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I. ON AN EXTRANEOUS MEAT SUPPLY.

By James Samuelson, Editor.

There is no subject which has engaged the attention of the British public during the last few years, of such paramount importance as the great "meat question." That staple food of our countrymen of all ranks has been gradually becoming more costly and difficult of acquirement; the highest class of agriculturists, the lettered men of the farm, although they have lost no opportunity to improve our breeds of domestic cattle, have observed with anxiety the constantly increasing demand and the disproportionate supply of live-stock; whilst our labouring classes, the muscle and sinew of the nation, have found the description of food which is, to them, indispensable for the performance of their daily toil receding month by month from their reach. And in this, as in all similar emergencies, it is becoming the fashion to look to "Science" for aid, and to censure her should the relief not be immediate and effective. Our coal supply threatens to fail us—"Science" must enable us to penetrate more deeply into the bowels of the earth; and whilst she teaches us to economize and husband our present supply, must provide us with a larger store in the future. She, too, must bring distant lands nearer, enabling us to draw upon their mineral wealth. Already we are told that an exorbitant price in the London market would attract a supply of coal from Westphalia. Civil war sweeps over the great cotton-growing districts of the West, and, in consequence, famine makes rapid inroads into our manufacturing centres. The products of other lands in the far East are considered unfit for our purposes; but soon the staple is improved abroad, new machinery is fitted up at home, and the bitter cup is averted by "Science."

Nor must it be supposed, because one section of the scientific community is directing its attention to abstract questions with respect to food, as, for example, the relative heat-giving and work-sustaining properties of nitrogenous and non-nitrogenous substances,

that therefore scientific men are regardless of the more practical aspect of that matter.

As we have already said, agriculturists are improving the breed of our cattle and seeking to bring a better supply to the meat market; manufacturers are multiplying our stores of artificial fodder, so that a good or bad season for pasture is of less moment than formerly, and each succeeding year brings us stores of fresh materials for this purpose from some new quarter of the globe; whilst chemists and meat curers are engaged in the keenest competition to preserve beef and other kinds of flesh abroad and at home; so that all the resources of art and science are being brought to bear in the effort to counteract the result of cattle plagues, the rapacity of butchers, and a rapidly increasing population.

But there is, at present, one grave obstacle in the way of obtaining effectual relief from a short supply of meat, which extends to hardly any similar substance, and that is the difficulty of importing it from abroad in its fresh condition. Cotton shipped from distant parts arrives here unimpaired in quality and undepreciated in value; so too coffee, tea, wheat, and hundreds of other necessaries and luxuries of life; but with the exception of smoked or salted flesh imported from a distance, and the limited supply of lean cattle brought from nearer countries, and rendered still more limited by cattle plague regulations, we have so far been unable to avail ourselves to any large extent of the live-stock of other parts of the globe. Something has, however, been accomplished, and in what condition we should have been, were that not the case, it is impossible to surmise. From Holland, Belgium, and other European countries we have for a long time past obtained supplies of lean-stock which has been rapidly fed in England (chiefly upon food originally the produce of Russia, India, and Africa), and placed upon our markets. Hams, bacon, and pickled or salted beef have formed a considerable feature in our North American import trade, and recent advertisements have informed the public that South American press-packed beef, of the finest quality and free from bone, is retailed "at a handsome profit to the dealer at fourpence per pound;" of the last named, it is right to say, that it cannot be looked upon as a description of food which will long maintain its footing, and the enterprising men who have so far succeeded in preserving their meat, must improve its quality, or it will not find its way into competition with our best English beef: to this subject we shall refer fully hereafter. A not unimportant feature in our meat-supply, and one for which we are solely indebted to Science, is the manufacture of the so-called "*Extractum Carnis*" of Professor Liebig, a process, as our readers are doubtless well aware, by which the nutritive properties of meat are condensed into a portable form, and brought from other parts of the world, from whence it would be difficult at

present to import live stock or fresh meat with any chance of its arriving here in a sound or healthy condition. From its concentrated form, and comparatively reasonable price, this extract of meat is now largely used in the preparation of soup, and the readers of such papers as the 'Pharmaceutical Journal' must see with surprise with what energy it is being pressed by the manufacturers upon the notice of the medical profession; it cannot fail to relieve in some degree the demand for fresh meat.

Still, there is a great outcry for an artificial, or rather for an extraneous supply of fresh meat, and when we come to look abroad, and consider the relative value of this commodity there and at home, we are not a little startled at the result of our inquiries. "First-rate meat is sold in the market at Buenos Ayres by the piece and not by weight, *a leg of mutton costing from* 10*d.* *to* 1*s.*, *and beef is comparatively cheaper*;"* the flocks of sheep about the River Plate are so numerous, that "the term of natural life of the animal renders it henceforth necessary that there should be annually slaughtered and, for want of a better means of utilizing them, 'boiled down' more or less 6,000,000 to 7,000,000 sheep, otherwise they would die natural deaths or from starvation, and their carcass-products, the main sources of a breeder's profit, be lost,"† and on an "Estancia" belonging to a well-known firm of breeders in Urugnay, which is now being converted into a joint stock company, with a view to the breeding and feeding of cattle and the preservation of meat for the English market, there are nearly 90,000 sheep, 5,600 head of cattle, and 1,200 horses, valued together at 59,227*l.*; in other words, the sheep are valued at about thirteen shillings each, and about 7,000 head of cattle and horses are thrown into the bargain gratis, whilst the "freehold" land is said to be "rich bottom land, with scarcely a stone to be found on it, irrigated by numerous rivulets, producing most luxuriant fodder for sheep and cattle," and it is set down in the valuation at eighteen and ninepence per acre.‡ In short, whilst in England the half-starved people are breaking into butchers' shops to enforce a reduction of meat upon tenpence a pound, the same staple may be bought within five weeks' steaming of us at a nominal price, and is annually *destroyed* in immense quantities to save the more valuable (because more easily preservable) fat and hides; and the land upon which the cattle is pastured may be bought under *a pound an acre!* We

* 'Report on the Methods Employed in the River Plate for curing Meat for European Markets,' by Francis Clare Ford, Esq., Brit. Chargé d'Affaires at Buenos Ayres. Presented to both Houses. 1866. London: Harrison & Sons.

† Letter of Mr. W. Latham to 'The Times,' dated Buenos Ayres, Sept. 25, 1867.

‡ 'Supply of Meat from South America,' by A. Prange, Esq. Mr. Prange wrote to the 'The Times,' Oct. 22, and his statement is confirmed by other writers in the same journal, that he can produce the best fed beef on his Estancia, Nueva Alemania, on the River Plate, at twopence per pound!

need not be surprised if here and there a practical man shakes his head sceptically, and asks, What is the use of Science if it allows such a state of things to exist?

As we have already said, the great difficulty to be overcome is the conveyance of the cattle to England or the preservation of the meat abroad, either in its raw state, or at least in such a condition as to render it fit to be brought into competition with English meat, and many persons are engaged both practically and experimentally in endeavouring to gain that end.

Mr. Ford, in his Report already referred to, notices three processes employed at Buenos Ayres for the preservation of meat, namely, Morgan's, Liebig's, and Sloper's; and Mr. Prange in his pamphlet mentions that of Messrs. Medlock and Bailey, of Wolverhampton.

"Mr. Morgan's process is based on forced infiltration," and he has adopted the circulatory system of the body as a means of introducing brine into the tissues. The operation is performed by allowing all the blood to escape through artificial incisions made in the heart of the animal after death, and by the subsequent injection into the heart, and through it into the whole circulating system, of a fluid consisting of water and salt ("one gallon of brine to the cwt."), and "a quarter to half-a-pound of nitre, carefully refined." The writer of the report considers this system of curing superior to that by means of salt outwardly applied, as he believes that the "natural juices and alimentary substances" are retained; and he says, "The meat has hitherto arrived in England sound and good, and I am enabled from personal experience to testify to the admirable quality of the samples I tasted which were inviting and palatable." It will occur to the reader, however, to inquire whether Mr. Ford tasted this "inviting and palatable" beef in Buenos Ayres before it was shipped (for his report comes from thence), or after it had passed through the ordeal of a long sea-voyage in the confined hold of a vessel; and if in Buenos Ayres, then, whence he derives the authority for his statement, that the meat "has hitherto arrived in England sound and good." We have often seen it exposed for sale, at a price below that of salted beef, and although it is sometimes purchased out of curiosity by the middle classes, we may confidently say that it does not compete with home-grown beef, and is of a very inferior quality.

Of Liebig's process, which Mr. Ford describes in detail, we have already spoken; and will now add a few particulars which may interest our readers. "The meat of the animal after being killed is allowed to cool for twenty-four hours; it is then placed in round iron rollers (armed inside with points) which, being revolved by steam, reduce the meat to a pulp. This pulp is thrown into a large vat with water, and allowed to steam for an hour, and is then passed into a reservoir (shaped like a trough with a sieve at

the bottom), from whence the fluid of the meat oozes into another vat from whence the fat is drawn off.* The pure gravy is then put into open vats supplied with steam-pipes and with bellows on the surface, which produce a blast and carry off the steam, thus helping the evaporation and preventing condensation. Here it remains from six to eight hours, when it is passed into a filtering vat and drawn off in the form of extract of meat. When cool it partially hardens, and is ready for packing in tins and exportation." Mr. Ford tells us that eight small tins will hold the concentrated alimentary matter of an entire ox, at the price of 96*s.*, and will make over 1,000 basins of good, strong soup, costing, therefore, rather less than a penny a basin.

Mr. Ford speaks rather doubtfully of Mr. Sloper's process;—and, whilst he is very enthusiastic about Morgan's (to which reference has been made), he says concerning that of Mc Call and Sloper, "These gentlemen profess to be able to preserve meat in its fresh and raw state, which is to arrive in England or elsewhere in the exact condition as butcher's meat just killed, &c., &c." He observes, in another part of his report, that the price paid for Morgan's beef is barely remunerative, so the other gentlemen are probably adopting the wiser course of bringing their system to perfection (if this can be done) before applying it in a practical manner. It must be clearly understood that we do not wish to discourage the attempt to preserve meat chemically, but believing that as at present imported it gains little favour, and is calculated to raise a prejudice which it may be found very difficult to remove hereafter, we would recommend the greatest caution in the practical application of any new system. Messrs. Medlock and Bailey use Bisulphite of Lime, and Mr. McCall Bisulphite of Soda in the preservation of his meat; both these processes are patented, and we believe the system of injection is employed as described above.

By far the most valuable, as it is the simplest, system of preservation, however, is that of packing the meat in tin cases as practised in America, Australia, and at home, and to this we shall now direct the reader's attention. At Mr. McCall's Factory in Houndsditch this operation may be seen in perfection, and no secret is made of the process. On entering the factory, the visitor is struck with the long rows of legs of mutton and venison, and pieces of meat to be preserved; and is introduced into a large shed where a great many butchers are employed in cutting the bone and a portion of the fat from the meat, and reducing it to a suitable form for preserving in tins. The raw meat is then packed tightly in these tins (varying in weight from half-a-pound to six

* We are quoting Mr. Ford, and must not be held responsible for the verbiage of a State document.

pounds), and a little water being added the lids are closed, a small hole being left in each of them; and a considerable number are then placed in a bath in such a manner as to leave the upper part of the tins exposed. This bath contains Chloride of Calcium in solution raised to about boiling point, and whilst the contents of the tins are boiling, the water escapes as steam through the holes punctured in the lids. After a time the air is all expelled, the holes are soldered up, and the tins with their contents transferred to another bath, but raised to 260 degrees, and should any of them be imperfectly soldered they at once begin to leak. After boiling there for some time the meat is in a fit state for being kept any length of time, and it only remains to ascertain whether the air has been perfectly excluded. For this purpose the tins are placed in a dry chamber warmed up to about 90 degrees, and are left there for a time. The workman then gives each tin a light tap at the upper end, and if it emits a hollow sound, indicative of a space below, he is satisfied there is a vacuum and marks the tin as perfect; but should the sound be dull, as though the meat were in immediate contact with the lid, such a tin is not considered fit for retention and is set aside. Meat so preserved is already very largely employed for ships' use, and it is hardly necessary to say that as so simple an operation may be, and is, performed abroad where meat is cheap, as well as in England where it is dear, the development of this branch of industry will have a most important effect upon our meat-supply.

The great desideratum will be to provide a quality of meat suitable for preservation, and as that applies to all systems, whatever they may be, we shall now direct our attention to this phase of the subject. Of the remarkable facilities which exist on the River Plate for the breeding of sheep and cattle we have already spoken, and we would now, in passing, direct the reader's attention to the illustration accompanying this paper, which will convey some idea of the appearance of an *Estancia*, or cattle-breeding and sheep-shearing farm in Uruguay. In the foreground are the cottage with its *Corral*, or cattle-pen, its store and shearing house, and in the distance, the sheds, wharf, and vessels loading hides, tallow, and wool. These are the chief products of the live stock, besides the calcined bones, which the breeder aims to secure, the flesh being quite a secondary matter, and all authorities are at present agreed that the meat offered for sale on the River Plate is not suitable for preservation and exportation. The reasons are that the cattle is wild and unfit for slaughter, that no attempt on a large scale has been made to breed such as would produce good meat, and that if even the stock sent to Buenos Ayres be of a good description when it leaves the Estancia, it arrives there "miserably fatigued, the effect of which on the meat cannot but be disastrous, as after that its nutritive power is

diminished and it cannot keep,"* and Mr. Latham considers that "it will take two or three pounds of Argentine meat *in its usual condition* to equal in nutritive value one pound of English-fed meat." It must therefore be obvious to every reflecting person, that if such meat be exported to England, and arrives here in the best condition, the price at which it is offered, say fourpence a pound, cannot afford a sufficient inducement to purchasers, who would find a better investment for their money in home-grown meat at sevenpence or eightpence per pound. There is, however, nothing impracticable in the way of feeding-up suitable animals, and the land and cattle owners do so for their own use on the farm. Mr. Prange writes to 'The Times': "I have every year reared a small number of oxen for household consumption, and I may safely say that their beef is as tender and juicy as the fine joints I dine off at this hotel."† "Beef," he further adds, "from the cattle as now reared can be bought in Uruguay at a half-penny per pound; and I shall make a fine business of it, if in a few years I can sell 6,000 oxen, fattened on my land, at 2*d.* per pound for the best beef."

Seldom have words of so encouraging a kind appeared in the leading journal, and we have no hesitation in saying that as such a result can be attained within four or five weeks' voyage of our shores, the time is not far distant when a large supply of wholesome meat will find its way into our markets. As long as there was no regular outlet for such beef—it being worth in Buenos Ayres less than a penny a pound, and employed only as "charqui," or jerked beef for export to Brazil and Havannah for the use of the slave population—it was not likely that the breeders would trouble themselves to improve its quality. Soon, however, it will come into competition with English preserved meat; and an Estancia has just been sold to a German Joint Stock Company established for the manufacture of the extract of meat, whilst another has for some time been worked by the "Antwerp Liebig's Meat Extract Company."

With respect to the improvement in the breed of Cattle, and the fattening of stock, there appears to be no difficulty whatever. Mr. Latham in his letter to 'The Times,' and in his excellent work on the River Plate, has discussed the subject fully and impartially,‡ and what he tells us agrees entirely with the statements of the owners of large Estancias. For many years past, English bred cattle has been imported for the purpose of crossing with and improving the native breeds, and on the better regulated Estancias good cross-bred

* Mr. G. Bell's letter to 'The Times,' October 28, 1867; and 'The States of the River Plate' (p. 140), by Wilfred Latham. Longmans. 2nd edition. 1868.

† Morley's.

‡ 'The States of the River Plate,' pp. 15, 19, 22, 23, 34, 44.

(short-horn cross) cows are kept. Oxen are also fed up (as stated by Mr. Prange as well as Mr. Latham) for the use of farmers, and the latter gentleman informs us that the produce of crosses of short-horned and Hereford bulls with selected native cows, when somewhat extra care is taken to secure the even growth, is, as he has seen and proved, highly satisfactory, especially in the third or more advanced crosses, and "on the same feed, they will make nearly double the beef and fat that can be attained from the native breed." As to sheep, Leicester, Lincoln, Southdown, and Shopshiredown varieties have been imported and successfully intercrossed with native breeds.

Then with regard to the feeding process. The natural resources of the country appear likely to suffice, without the necessity of importing artificial food. There is "succulent, as well as tall, sedgy, and hard grass,"* and the grasses are more tender and less coarse in the province of Buenos Ayres than in the other provinces. We are informed also by the owners of large Estancias that some of the pastures teem with rye-grass and clover. Moreover, we find that many flesh, as well as fat-forming grains, such as wheat, barley, and Indian corn, are largely grown, whilst the oleaginous seeds, such as linseed, &c., could easily be cultivated. Mr. Latham even speaks of a wild thistle growing in "camps," and covering immense tracts of land, on the oleaginous seeds of which the sheep feed and grow fat. All the requisites for artificial feeding are therefore accessible, and there is really no reason why the finest stock should not be raised there, as it is in England. Nevertheless this work should not be left to untutored hands, and we cordially endorse Mr. Latham's recommendation, that if the attempt be made to produce and fatten stock for exportation, alive or dead, "such an initiatory and experimental undertaking must necessarily be placed under the direction of men who have a good practical and theoretical knowledge of cattle feeding, and also of the country, its climates, products and agricultural capabilities, together with perseverance and zeal."† As to the difficulties of conveying the meat to England when a good quality is obtained, those will, we think, be found to diminish year by year. If it has been possible to transport selected stock in safety from England to the Plate for breeding purposes, it is obvious that there can be no serious obstacles to the importation from thence of live stock, more especially if large steamers are fitted up for the purpose. In fact the Liverpool steamers to the River Plate have already commenced to carry deck-loads of live sheep from thence to Rio. The next plan is that of preservation in closed packages as already described, in which case the meat should be lean, and *flesh-forming* food should, we think, be largely used in the feeding

* 'States of the River Plate,' p. 15. † Ibid., p. 46.

process. Of the chemical preservative operations we have already spoken at length. At present they do not inspire much confidence where the object is to preserve meat for long voyages, for if there be anywhere in the world a fastidious diner, it is the Englishman of every rank. What improvements in these systems may be introduced concurrently with the production of an improved quality of meat abroad we are unable to say, but we would recommend those who are practically engaged in the rearing of cattle and the preservation of beef to turn their attention to the smoke drying and curing processes already in use. In this case also the cattle must not be too fat, for the fat decomposes more readily than the flesh: and of the curing processes known to us, that which appears the most likely to be immediately successful and remunerative is the one by which "Hambro' smoked beef" is prepared. This kind of beef is becoming a great delicacy even in England; and as the breeders on the Plate have, from their associations and connections (many being Germans) peculiar facilities for perfecting the process there, where the raw meat has only a nominal value, we hope soon to see it sent over in large quantities, and of a quality equal to that now imported from Germany.

These are a few of the numerous devices by which it is sought to supply our home market with imported meat of a wholesome and nutritious description, and the reader will perceive that the resources of trade, navigation, art, and science are being brought to bear in the execution of this all-important object. There is no unmixed evil: indeed what we in our ignorance are apt to regard as an evil is often designed by Providence as the incentive to exertion and progress; had it not been for the alarm excited by the cattle plague, it is not improbable that the vast resources of the River Plate and of our own Australian Colonies, to the development of which the energies of the adventurous trader and agriculturist are now being directed, would have lain dormant for years to come, until perhaps, with an increased population, we should have found ourselves reduced to an extremity and exposed to fatal dangers which may now be happily averted.

II. ON THE MECHANICAL PROPERTIES OF IRON AND STEEL.

By W. Fairbairn, F.R.S.

Henry Bessemer, like his prototype, Cort, has effected a revolution in the manufacture of iron and steel; and the present improvements exhibit a means of development by which the former will ultimately double its strength, and in the state of steel be substituted for purposes of construction. The result of this change, when applied to structural purposes, is considerable, as half the weight of steel is equal in strength, and consequently is cheaper than a given weight of iron. In almost every case where iron is at present used, steel would then be employed: as in the construction of bridges, ships, and other structures to which iron is now applied. It only requires certainty and uniformity of character in its manufacture, to ensure its superiority and extend its application. This has not as yet been accomplished; but the Bessemer process, by depriving the crude metal of its carbon in a separate vessel, certainly tends in that direction; for by this process increased facilities are not only afforded, and new combinations formed, but the introduction of measured quantities of the same metal, containing the requisite quantity of carbon, poured into the converting vessel, appears to be the only true principle on which steel in its varied conditions of ductility, tenacity, &c., can be produced. These quantities, when duly proportioned, indicate the quality of the steel to be obtained from this process, and, when cast into ingots are ready either for the forge or the rolling-mill. From this it will be seen that every description of homogeneous iron or steel may be produced, care being taken to ascertain the exact percentage of carbon requisite to be infused in order to combine with the mass of refined metal.

This process of conversion as adopted by Mr. Bessemer is entirely new, when compared with the old method employed in the converting furnace with the bars embedded in charcoal, which required at least a fortnight for the refined iron to absorb the necessary quantity of carbon to form steel. By the new system steel is produced in the Bessemer vessel in less than twenty minutes, whereby a great saving of time, fuel, and other expenses is effected. As this process is extremely interesting, it may be briefly described as follows:—

A quantity of pig-iron, containing an average quantity of carbon, say 5 per cent., is melted in one or more reverberatory furnaces, according to the size of the converting vessel to be used, which varies in capacity from five to ten or twelve tons. When the metal becomes fluid, it is run into the converting vessel, to which is

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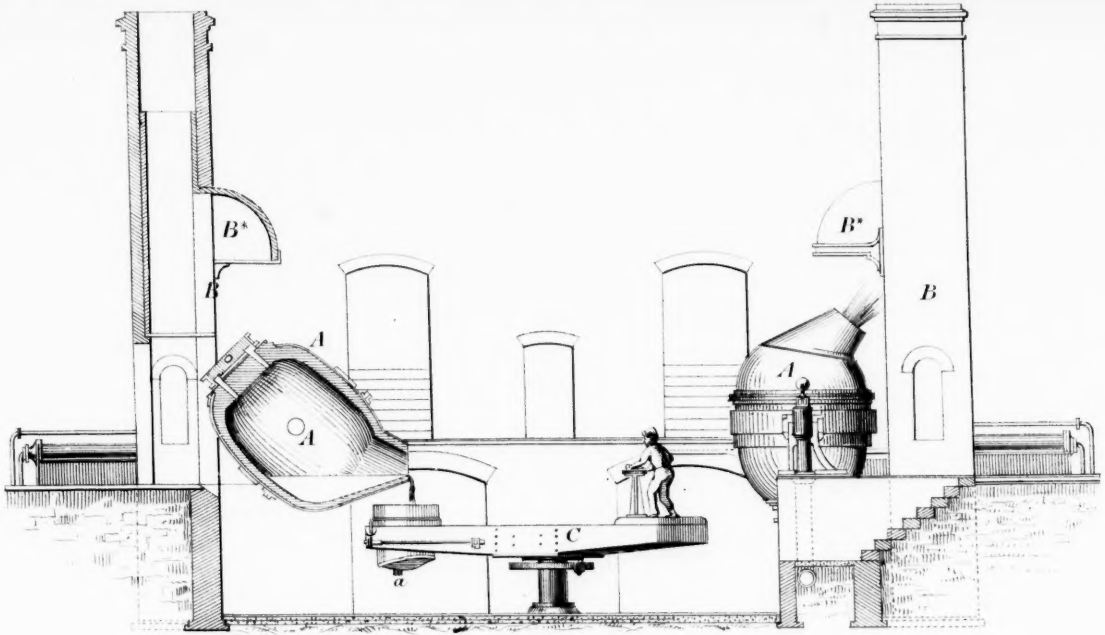

W. Fairbairn. del.

M & N Hanhart. lith.

THE BESSEMER STEEL MAKING PROCESS.

applied a strong blast of air, which combines with the carbon at an intense white heat. This is continued for about eight or ten minutes, until the whole of the carbon is consumed, when the blast is stopped. In this stage a quantity of metal, containing the requisite percentage of carbon necessary to form the exact quality of the steel required, is poured into the vessel, and this combining with the refined iron gives to the mass all the properties and characteristics of steel.

To show the facility with which the crude iron may be converted into refined iron or steel, the converting vessel may be placed if necessary so near to the blast furnace as to allow the iron to flow direct into it; or the metal in the shape of pig-iron may be melted in reverberatory furnaces, as is now generally the case, and thence run direct into the converting vessel. This vessel is of the shape shown in the Plate, supported on trunnions at A, which enable it to turn upon its centre and discharge its contents into a large ladle when the process is complete. The general apparatus will, however, be better understood by referring to the Plate, which is a view of the interior of the converting house. It will be seen that two vessels, A A, are employed; they are placed in such a position as to throw the sparks and slag away from each other, and into the lower part of the chimneys, B B, which have hoods at B* to conduct the flame into them. The casting pit is semicircular in front, and central to it is placed the casting crane C, which supports the ladle into which the steel flows, and from which it is delivered through a cone valve, *a*, at the bottom of the ladle. One of the vessels is shown in section in the act of pouring out the fluid steel into the ladle, while in the other the process of conversion is going on. When necessary both vessels may be worked at the same time, and their contents poured into one large ladle, so that an ingot of 20 tons may be made from what is usually styled a 10-ton apparatus. It will be observed that the hydraulic casting crane, C, is brought so far from the line formed by passing through the centres of the converting vessels as to allow one vessel to be moved round if necessary, while the ladle is in front of the other vessel. This position of the crane enables the casting pit to be made larger, and gives more space for the moulds.

In the act of pouring the steel from the converter into the casting ladle, the crane is steadily lowered and its bend moved round to accommodate the curved path in which the spout of the converting vessel moves. This lowering of the crane is effected by a boy on the valve stand, which is situated at a distance of about twenty feet from the casting pit, and in a line with the centre of the casting crane. On this stand the cocks for the moving of the vessel are placed; here also are the handles of two large balanced air-valves by which the blast is regulated.

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To ascertain the comparative values of steel when subjected to transverse, compressive, and tensile strains, the following abstracts of results have been taken from "Fairbairn's Experimental Researches" on the mechanical properties of Steel in its present improved state of manufacture.

Abstract of Summary of Results from the Experiments on Transverse Strain.

Manufacturer.	Mean value, D, of the deflections for unity of Pressure and Section.	Modulus of elasticity, E, corresponding to 112 lbs. Pressure.	Work of deflection, U, for unity of Section.	Value of C, the unit of Working Strength.
				Tons.
Messrs. Brawn & Co.	·0012739	31,551,000	52·721	5·918
„ Cammell & Co.	·0013518	30,630,000	5·9897	5·921
„ Naylor & Vickers. . . .	·0013007	29,481,000	65·049	6·548
„ S. Osborn & Co.	·0014296	27,540,000	52·574	5·622
„ Bessemer & Co.	·0016384	28,673,000	49·489	5·659
„ Sanderson Brothers . .	·0013229	29,355,000	47·411	5·521
„ Turton & Sons	·0013120	30,750,000	52·680	5·886
The Titanic Steel Co.	·001235	33,088,000	63·542	6·435
Mean.	·0013615	30,141,000	55·420	5·939

In this short abstract we are unable to give the experiments in full or the General Summary of Results, our limited space admitting only the mean value of each sample of bars as received from the different works. These bars were of different qualities, and were tested separately in order to determine their tenacity, elasticity, ductility, &c., and the details of each are given separately in the general table of Results. From these tables we have merely taken the mean of the resistances to strain and the working values of the bars as determined from the experiments and the samples, taken collectively, from each marker. In the general report, the strength and other properties of the different specimens are given separately, and for these details we must refer the reader to the 'Transactions of the British Association' for 1867.

It will be observed that the above and the following tables of Results are taken from the General Summary, where the deflections, elongations, and compressions are carefully recorded; and from these are deduced the different powers of resistance and working value, as exhibited in the columns of each table. The difference in this case is, that the mean results are taken from the whole number of specimens received from each maker, and not from the separate bars experimented upon, as given in the Tables.

The first column gives the names of the makers, or the works from which the steel was obtained; the remaining columns give respectively the deflections for unity of pressure and section, the modulus of elasticity corresponding to 112 lbs. pressure, the work

of deflection and the unit of working strength, which is the mean value or working tenacity of each set of bars, as deduced from the experiments in their collective form.

Abstract of Summary of Results from the Experiments on Tension.

Manufacturer.	Weight laid on in lbs. producing rupture.	Breaking Strain per square inch of Section.	Corresponding elongation per unit of length.	Value of U, or work producing rupture.
		Tons.		
Messrs. Brown & Co.	33,603	40·35	·0781	2005
„ Cammell & Co.	33,718	45·14	·0591	2714
„ Naylor & Vickers	39,448	48·25	·0372	1826
„ S. Osborn & Co.	44,129	46·07	·0340	1842
„ Bessemer & Co.	38,189	40·15	·0753	3212
„ Sanderson, Brothers	39 592	42·65	·0229	1253
„ T. Turton & Sons	39,925	41·61	·0165	807
Mean	38,372	43·46	·0461	1951

From the above it will be seen that the mean of all the specimens of steel experimented upon is greatly in excess of iron, which, taken at a breaking strain of 20 tons per square inch of section, gives a ratio of 43·46 : 20, or as 2·17 to 1, being more than double that of iron in its resistance to tension. These and previous experiments clearly show the advantages which this material has over iron in its malleable state, and the important benefits which it is likely to confer when rightly applied in constructive art.

Abstract of Summary of Results from the Experiments on Compression.

Manufacturer.	Greatest weight laid on per square inch.	Corresponding compression per unit of length.	Value of U, or work expended in crushing the bar.
	Tons.		
Messrs. Brown & Co.	100·7	·347	39,101
„ Cammell & Co.	100·7	·339	38,231
„ Naylor & Vickers	100·7	·287	32,300
„ Osborn & Co.	100·7	·267	30,014
„ Bessemer & Co.	100·7	·379	42,720
„ Sanderson, Brothers	100·7	·328	36,906
„ T. Turton & Sons	100·7	·260	29,256
Mean	100·7	·315	35,504

This table shows the resisting powers of steel to a force tending to crush it; the middle column exhibits the amount of compression produced by 100·7 tons, the mean of which is ·315.

These experiments also indicate the superior resisting powers

of steel, which in every case is greatly superior to iron in all the varied forms of resistances to strain to which it may be subjected.

We have given this short abstract from a long series of recent experiments in anticipation of steel superseding iron in almost every case where strength is required. That the time is not far distant when this will be accomplished, we have every reason to believe, and assuming that the change will be of great national benefit, we shall hail with the liveliest satisfaction the disappearance of iron and the substitution of steel as a superior material for general purposes of construction.

III. ON EXPERIMENTS FOR ASCERTAINING THE TEMPERATURE OF THE EARTH'S CRUST.

By Edward Hull, F.R.S.

The question of the rate of increase of temperature of the Earth's crust from the surface downwards is one which engaged the attention of members of the British Association at the recent meeting in Dundee, and to the investigation of which, by actual experiment, the Association is likely to devote some portion of its funds. In anticipation of such operations, we venture to offer a few observations both as regards what has been done and what may be done and the mode of doing it, even at the risk of suggesting matters which have already occurred to the minds of those who are to carry out the experiments entrusted to them. It is desirable that whatever money and labour are to be devoted to this purpose should not be uselessly expended in the repetition of observations which have already been made with a degree of accuracy as great, perhaps, as the case admits of, but that they should be used in perfectly new and untried grounds, or, in other words, for the testing of hitherto unexplored depths. Before entering, however, upon this branch of our subject, we shall prepare the way by bringing to the reader's notice examples of what has already been done by previous investigators.

Although the opinions of philosophers regarding the condition of the internal nucleus of the globe are widely different, all are probably agreed as regards an actual increase of temperature from the surface downwards to an unknown depth; and that this is the fact the evidence both of a theoretical and experimental character is probably conclusive. It is no argument against this view that we find strata, in their natural or unaltered state, which on stratigraphical grounds we believe to have been at one time buried beneath newer strata to a depth of several thousand feet; for assuming the increase of heat to be at an average rate of 1° Fahr. for every 60

feet, the boiling point of water would not be reached under 12,720 feet; and while on the one hand it is doubtful whether metamorphism would take place in ordinary strata at this temperature, it is seldom we meet with rocks which we are certain had originally been buried at much greater depths.

Whether this increase of temperature is continuous for any considerable distance in reference to the semi-diameter of the earth, or whether it increases or diminishes according to definite laws, are questions which are probably beyond solution by actual experiment, for, in the words of Humboldt, the question of the internal central heat, as a mathematical problem, "yields rather negative than positive results." The experimental evidences, however, as far as they come within the range of investigation, all point to one conclusion. They are also of several kinds, derived from observations of the temperature of the water springing from different depths through artesian borings—those obtained from testing the temperature of the water issuing from coal-seams and fissures in mines, and those obtained from observations made during the sinking of mining shafts both through wet and dry strata. It is on the experimental evidences we propose here to dwell, and taking some examples from authorities within our reach, to present the reader with a succinct account of what has already been achieved, and afterwards to offer some suggestions as to the best manner, in our opinion, for pursuing further investigations.

One of the most remarkable and carefully-observed cases of artesian borings is that of the Puits de Grenelle, near Paris. The sinking of this bore-hole was watched by Arago till 1840, down to a depth of 1,657 feet, when the borer had left the Chalk formation, and was beginning to penetrate the Gault. The series of observations were completed by Walferdin in 1847. The surface of the basin of the well at Grenelle lies at an elevation of 119 feet above the sea, and the borings extend to a depth of 1794·6 feet from the surface. The water which rises from the Lower Greensand formation is of a temperature of 81·95° Fahr., and the increase is at the rate of 1° Fahr. for every 59 feet.*

The next boring we shall describe is that of Neu Saltzwerk, in Westphalia, and situated 231 feet above the level of the sea at Amsterdam. It penetrated to an absolute depth of 2,281 feet from the surface. The salt-spring lies, therefore, at a depth of 2,052 feet below the level of the sea, a relative depth which is, perhaps, the greatest that has yet been reached. The temperature of the brine is 91·04° Fahr., and as the mean annual temperature of the air at these works is about 49·3°, we may assume there is an increase of 1° Fahr. for every 54·68 feet.† This boring is 487 feet deeper

* 'Cosmos.' Trans. of Otté and Dallas, v. l. v., p. 35–6. † Ibid., p. 36–7.

than that of Grenelle, and the temperature of the water is 9·09° Fahr. higher.

An artesian boring in the vicinity of Geneva to a depth of 724 feet, and at an elevation of 1,600 feet above the sea-level, showed the increase to heat at the rate of 1° Fahr. for every 55 feet; while another at Mendorff, in Luxemburg, which penetrated to a depth of 2,394 feet, gave a result of 1° Fahr. for every 57 feet. This boring is particularly interesting and valuable, not only for its depth, but from the fact of its passing through several formations, including the Lias, Keuper, Muschelkalk, Gies bigarré, and entering slaty rocks.*

Some years since, Mr. R. Were Fox undertook a series of experiments on the temperature of the Cornish mines, which are reported in the 'Transactions of the British Association.'† These experiments appeared to show that the increase of temperature was in a decreasing ratio to the depth; but it is to be recollected that in the case of mines, the temperature is affected by several sources of error, such as the spontaneous combustion of pyrites. The results, however, are not without value, and are as follows:—

At a depth of	354 feet	the temperature was	60° Fahr.
,,	792 ,,	,,	70° ,,
,,	1,434 ,,	,,	80° ,,

Assuming the invariable temperature, presently to be explained more fully, to be 50° Fahr., the rate of increase would be arrived at as follows:—

10° at 354 feet, less 50‡ = 304 feet,	or 1° in 30·4 feet.
of 10° at 438 ,,	or 1° in 43·8 ,,
and of 10° at 684 ,,	or 1° in 64·2 ,,

The observations taken in the Tresavean mine in 1837, which were the deepest of the series, gave the following results:—

At 1,572 feet from the surface the temperature was		82·5° Fahr.
At 1,740 ,, ,, ,,		85 3° ,,
At the above depth in another lode	,,	86·3° ,,
,, in a third lode	,,	92·1° ,,
Giving the mean temperature for a depth of 1,740 feet		87·9° ,,

Mr. R. Hunt, F.R.S., who has made some observations in reference to the question of increase of temperature in mines, states that he has found the temperature as high as 100° at a depth of 1,920 feet (320 fathoms) in the Tresavean mine.

Several carefully executed experiments carried on in coal mines have been recorded; and amongst the earliest on which much reliance is to be placed, are those of Professor J. Phillips, F.R.S., at

* 'Cosmos.' Trans. of Otté and Dallas, vol. v., p. 3–56. † Vol. ix.

‡ 50 feet from the surface is here assumed as the depth of no variation of temperature all the year round.

Monkwearmouth Colliery, near Sunderland, at a depth of 1,590 feet, from water issuing from a coal-seam at a depth of 1,499 feet below the sea-level, and which gave a resulting increase of temperature of 1° for every 60 feet.*

During the sinking of Rose Bridge Colliery, near Wigan, to the celebrated Cannel-seam, between the years 1854–61, careful observations of the increase of temperature were made by the manager, Mr. Bryham, and communicated to the author; the following are the results:—

At a depth of	483	feet	the temperature was found to be	64·5°	Fahr.
"	564	"	"	66°	"
"	1,650	"	"	78°	"
"	1,800†	"	"	80°	"

Taking the invariable temperture at 50°, and at a depth of 50 feet, the resulting rate of increase is 1° Fahr. for every 58·3 feet.

But of all the observations as yet made, perhaps the most elaborate are those which were undertaken by Mr. W. Fairbairn, F.R.S., during the sinking of the Astley Pit of the Dukenfield Colliery in Cheshire.‡ These observations were carried on over a period of ten years (between 1848–59), and reach downwards to a total depth of 2,151 feet from the surface. Great care was taken to remove the thermometer from the disturbing influences either of the air in the shaft, or of water in the strata. The instrument was as often as possible inserted in a dry borehole in advance of the sinkings, and left in its bed from two hours to two days, according to circumstances. Fifty-two observations are recorded, and range from an invariable temperature of 51° Fahr. at a depth of 16½ feet from the surface to 75·5° at the bottom of the pit, and 75·0° at 22 yards lower in the roof of the "Black coal," taken seven months afterwards. This last observation does not in all probability give the original temperature of the stratum, which we may well suppose was somewhat lowered, owing to contact with the air. Rejecting for the above reason the last observation, we find that there has been an increase of 24·5° in 2,040 feet; so that the average rate for the whole depth is 1° for every 83·2 feet.

This series of observations is the most valuable of any that have been made in this country, both as regards the unsurpassed depth to which they extended, and the care that was taken to ensure accuracy. On the whole (with occasional minor variations) they show a remarkable uniformity in the rate of increase, and induce confidence

* 'Philosophical Magazine,' vol. v.

† Another observation was made nine months afterwards, when it was found the temperature had cooled down 8°, or from 80° to 72°, owing to contact with the down-current of air.

‡ See account of these observations by Mr. W. Hopkins, F.R.S., in the 'Philosophical Transactions,' vol. cxlvii.

in the results. From the following analysis, it will be observed that at the lowest depths the rate of increase was nearly as great as at any portion of the descent:—

The first observations gave 51° as the invariable temperature at a depth of 16½ feet, as already stated.
Between 693 feet and 710 feet the temperature was nearly uniform at 58°.
Between 710 and 927 feet the rate of increase was 1° for 62·4 feet.
Between 927 and 1,257 feet the rate was 1° for 60 feet.
Between 1,257 and 1,839 feet the rate was 1° for 86·91 feet.
Between 1,839 and 2,055 feet the rate was 1° for 65·6 feet.

And the mean of the whole series of observations gives 1° for every 83·2 feet, which is under the average of the observations.

The increase of temperature appears to be independent of altitude, of the place, or of the density of the air, as proved by the observations of Humboldt.* Thus, in a silver mine in the Andes of Peru, at an elevation of 11,875 English feet above the sea, the temperature was found to be 25·4° Fahr. higher than the external air. In another mine at the same elevation, the difference between the temperature of the internal and external air was found to be 15·8° Fahr., and the water streaming down the rock showed 52·3° Fahr. These observations were repeated in other localities with similar results.

The concurrent testimony, therefore, of all the observations which have been made, is in favour of an increase of temperature, though at rates varying considerably from one another, and this has been established as holding good down to a depth of about 2,400 feet from the surface. What seems to us now to be required, and for several reasons, is a series of experiments made at even greater depths.

First.—With so many recorded observations, all approximately concurring towards one conclusion, any sinkings or borings to a depth of less than 2,000 feet would, in all probability, only afford another series of similar results, and would be so much money uselessly expended; and secondly, it seems probable that at greater depths several sources of error would be avoided. Of all these sources of error—the percolation of water through the strata—is probably the most formidable; now it has generally been found that the quantity of water in coal-mines derived by percolation from the surface, decreases in proportion to the depth, and that at depths greater than 500 or 600 yards the mines are dry. It is somewhat difficult to account for this where there are thick beds of porous sandstone, but it is to be recollected that a rock which is full of joints and fissures at the surface, is often found extremely solid at a considerable depth, and the friction, or resistance to percolation,

* 'Cosmos,' Sabine's Trans., vol. iv.

of the particles of which it is composed, offers an accumulative obstacle to the passage of water downwards, more than balancing the hydrostatic pressure, and amounting at length to an absolute stoppage. This is a conclusion which wells in the New Red Sandstone—itself a very porous rock—seem to offer, for after a certain depth has been reached, the increase of supply appears to take place in a diminishing ratio to the depth,* and we may suppose a zero point would ultimately be reached.

As far, then, as our experience goes, it is very probable that at depths greater than 2,000 feet, no water would be found in ordinary coal-measure strata, and thus by sinking in this formation a principal source of error would be avoided. Other sources of error (such as those arising from differences in density, and conducting power in the several varieties of strata) being of less moment, would disappear, or become inappreciable, on taking the mean temperature of very deep borings.

After much consideration, the plan which we venture to recommend, in case of experiments being undertaken by the British Association, or any other scientific society, would be, not to commence at the surface, but at the bottom of a coal-mine, of not less depth than 600 yards.

There are several collieries, particularly in Lancashire and Cheshire, sufficiently deep for the purpose. It would be an easy matter to excavate a chamber in the coal and its roof, where the borings might be carried on. The chamber ought to be a short distance from the bottom of one of the shafts, and out of the way of mining operations. As the process of boring progressed, observations should be taken at every 10 yards, and at every change of strata from sandstone to shale, or coal. The boring might be carried down at least to a total depth of 1,000 yards from the surface, and having been completed under proper supervision, could not fail to give results of value to science. It is also probable that a proprietor of some colliery of the required depth would willingly afford the facilities for carrying on the experiment for the sake of the information he would derive regarding the minerals underlying the coal-seam then being worked.

Before closing these observations, some further explanation is required regarding the depth of invariable temperature, or, in the words of Humboldt, the depth of "the invariable stratum." The surface of the earth undergoes a change of temperature according to the season of the year. In summer the rays of the sun and the warmth of the atmosphere affect the surface and penetrate gradually downwards with decreasing intensity, while in winter the cooling

* As may be gathered from the account of the sinkings at the Green Lane Well of the Liverpool Corporation Waterworks. See 'Quarterly Journal of Science,' vol. ii., p. 421.

influences prevail from the surface downwards, and the result is, the formation of an envelope or stratum of invariable temperature at a short and variable distance from the surface all over the globe. The temperature of the invariable stratum approximates to that of the mean annual temperature of the place, and, according to Humboldt, its depth is regulated by the latitude (increasing from the Equator towards the Poles), by the conducting power of the rock or soil, and by the amount of difference between the temperatures of the hottest and coldest seasons. At Greenwich, the mean temperature is 49·5°, and that of the invariable stratum about 50·5° at a depth of about 50 feet from the surface.

It will be evident, on reflection, that the stratum of invariable temperature is the standard of departure for all measurements at greater depths, and this point would require a separate series of experiments for its determination at the locality selected for the deep borings; but for ordinary purposes it is probable 50° Fahr., at a depth of 50 feet, may be taken as the temperature and depth of the invariable stratum over the greater part of Central England.* In the latitude of Paris (48° 50′) the depth and temperature of the *Caves de l'Observatoire* (86 feet and 53·30 Fahr.) are generally regarded as those of the invariable stratum.

It is scarcely necessary to point out the questions on which an accurate series of observations extending to great depths might throw light. As one illustration, we may select the subject of metamorphism of rocks, which is full of difficulties requiring solution, such as that presented by the rocks of the highlands of Scotland, where we find the metamorphosed Lower Silurian rocks reposing on unchanged Cambrian sandstones. Again, the change of bituminous coal into anthracite is only as yet partially explained in such instances as those of South Wales and the coal-field of the Don, where the same beds occur in both forms at opposite sides of the field. The nature and the fluidity of the interior of the earth itself is also at this moment (and probably ever will be) a matter of controversy among physical philosophers,† and one of those questions on which possibly some light might be thrown by the proposed experiments, though considering the small fraction of the earth's radius which comes within reach of man's feeble operations, one cannot be very sanguine on this head. It is to be remembered, however, that in prosecuting physical researches, it is not necessary to have a definite end in view, except that of adding to our knowledge. No new and well-certified observation will be allowed to lie for ever useless.

* See Professor Forbes' "Experiments on the Temperature of the Earth at different Depths."—'Trans. Royal Society of Edinburgh,' vol. xvi., 1849.

† I refer more particularly to the views stated by Dr. Sterry Hunt in his lecture before the Royal Institution, London; and the reply thereto by Mr. D. Forbes.—See 'Geological Magazine,' vol. iv., pp. 357 and 413.

IV. THE PAST AND PRESENT OF CHEMISTRY.

By Dr. Herrmann Kopp,
Professor of Chemistry in the University of Heidelberg.

Chemistry is generally regarded as one of the youngest of the sciences, and as exhibiting most unmistakably several characteristics of youth. Some think that, whilst she has made rapid progress of late, her development has achieved, in some aspects at least, but little of a solid and lasting character. Others allege, as a characteristic of her youth, that she often presumptuously gives her opinion and advice. She brings her judgment, supported by knowledge only just acquired, to bear upon older sciences, whilst she claims to be heard in the discussion of subjects with which her elder sisters have earnestly occupied themselves for centuries. In fact the venerable science of medicine, with her continually changing aspect, the somewhat younger natural philosophy with her glorious modern developments,—these and many other sciences long held in respect, may assert that they were already well grown when chemistry was still in her babyhood, talking nonsense, and manifesting the most perverse tendencies,—that they can remember the time when they took the infant under their fostering care, and led her by the hand.

Chemistry cannot deny this. She even gratefully acknowledges it, notwithstanding that, under their care, she was at times somewhat grossly maltreated. She cannot avoid the confession that, in her present aspects and pursuits, she is still very young; on the other hand, however, she may fairly plead that she does not quite date from yesterday. She can prove by documents, which, though not altogether indisputable, have yet considerable claims to authenticity, that she was at least in existence 1,500 years ago. It must be admitted that this is a respectable age, although insignificant as compared with that of some other sciences whose birthdays are lost in the gray mists of antiquity.

How can this ripe age of chemistry be reconciled with the youthfulness to which she generally confesses, and on account of which she has not unfrequently to submit to many reproaches? The mystery is explained when we take into consideration that the science which was known as chemistry to the ancients occupied itself with the solution of problems of an entirely different nature from those which engage the attention of chemists at the present day. For a long period chemistry, with childish illusion, pursued a phantom, and attempted the solution of an insoluble problem. Comparatively recent is her occupation with the task which we now consider to be her legitimate employment, and which as regards her way of dealing with it, we now look upon as the correct

method of investigation. Chemistry had a long childhood, and the more mature phases of her life are compressed into a comparatively short and recent period. Chemistry in childhood and chemistry in youth are almost as two distinct individuals. Let us endeavour to compare the characteristics of this childhood and this youth—the problems of the one and the pursuits of the other—the past and present of chemistry.

If we search for a connecting link between early and modern chemistry, we find it in a problem, the solution of which has occupied the minds of chemists in all ages. This problem, always more or less prominently kept in view, is the composition of the different substances found in nature or produced by art—the different heterogeneous materials which can be extracted from, or made to combine and form, a homogeneous substance.

The ancients made hardly any attempt to ascertain the chemical composition of substances. First, among the Greeks, and later among the Romans, we find sagacious observations on the diversities of bodies, but it was rather the physical than the chemical differences concerning which scientific observations were made. According to the doctrines of Aristotle, which, promulgated 2,200 years ago, so long maintained their authority, the fundamental properties of everything corporeal and palpable were considered to be dryness or moisture (that is, solidity or liquidity), and warmth or coldness. These are obviously physical conditions and different degrees of a physical property, and on the occurrence and the proportion of certain of these fundamental properties, other qualities, such as density or lightness, hardness or softness, were thought to depend. The assumption of the four elements, Earth, Water, Air, and Fire, offers to the mind a representation of the simultaneous occurrence of these fundamental properties. To Earth, as the representative of all solids, were ascribed dryness and cold; to liquid Water, moisture and cold; to Air or vapour, moisture and heat; to Fire, heat and dryness. The four elements of Aristotle represented fundamental conditions of matter, and the properties of bodies were regarded as depending on the proportion in which they contained the elements—the producers of those qualities. The whole conception was formed from a physical point of view rather than from one having even the faintest approximation to that of chemistry. The elements of Aristotle, as such, were not regarded as contained in different substances—as combining to form them, or as separable from them by analysis. The assumption of their existence did not therefore involve even the merest rudiments of a chemical idea. They were not regarded as different kinds of matter, but as different fundamental conditions which, when added to indifferent matter, endowed it with various properties.

This view, that the difference of bodies depended essentially

upon their physical properties, was the natural consequence of the slight knowledge of chemical qualities which the ancients possessed. The idea of chemical composition had not yet been conceived except, perhaps, in its very crudest form, as suggested by the composition of metallic alloys artificially prepared. But the well-known metals were scarcely distinguished from each other; thus lead and tin were regarded by the Romans as differently coloured varieties of the same metal—as dark and light lead. Of the most important chemical problems, such as those relating to combustion, to the changes effected in metals by the action of fire, or the caustic qualities of quicklime, we find scarcely a single one proposed, still less any attempts made at their solution. In regard to their knowledge of chemistry the ancients may be compared to ignorant or half-educated tribes of the present age; knowledge of important chemical phenomena they did not lack, but they made no attempt whatever to discover the causes of these phenomena.

This almost total ignorance on the part of the ancients, especially the Greeks, of any of the aspects of chemistry, is due entirely to their method of scientific investigation. Chemistry is essentially an experimental science, but experimental methods were little known either to the Greeks or Romans. The favourite mode of investigation with the most highly-cultivated people of antiquity, consisted in attempts to attain, by a pure effort of the intellect, to the conception of an universal principle by means of which all phenomena might be predicted and explained. Such a method of research could not even enable them to approach the domain of a science like chemistry. A few centuries later, however, we find the art of experimenting more advanced, and a real, if somewhat vague attempt being made to obtain a knowledge of the chemical composition of at least one class of bodies. It is true that this knowledge was sought after, not for its own sake, but as an aid to the solution of the problem of the transmutation of the common into the nobler metals. Alchemy existed in the fourth century of our era, and for more than a thousand years presented almost the only, and certainly the most important field for the development of chemistry.

Our knowledge of the spread of alchemy, and of the resulting progress of chemistry, is very defective for the period between the fourth and the thirteenth centuries, and we know nothing whatever of the origin of alchemy, nor where it was first attempted. All that can with certainty be said is, that alchemy is undoubtedly older than the most ancient testimony that has reached us concerning it (from the fourth century), for this testimony does not speak of it as a new pursuit but as one which had long been carried on. The confident assertions regarding the practicability of alchemy do not now concern us, but it is important to a clear comprehension of the

present state of chemistry that we should know what were the grounds of the belief that one metal could be transformed into another.

The foundation of this belief was a theory of the cause of difference in matter, which finds its best expression in the doctrine of Aristotle already alluded to, that matter itself is everywhere one and the same thing, and that its varieties are produced solely by a variation of its qualities. Changes in the properties of substances, and especially of metals, were recognized at an early period. Thus it was known that, by the action of certain substances, copper could be made as yellow as gold, and, by that of others, as white as silver, the transformation being effected throughout the entire mass. We now know that when red copper is turned into yellow copper (brass) or into white copper (German silver), a change takes place in the composition as well as in the colour; but at the period when alchemy flourished, such a change was not thought of any more than we now consider it as taking place when soft steel is transformed into hard steel—a transformation with which the ancients were also acquainted. The hardness, colour, ductility, fusibility, and some other properties of certain metals could be altered, and hence it was thought that it must be possible so to change all the properties of one metal into those of another, that the one metal would really be transformed into the other. Until the fifteenth century, and even somewhat later, the idea underlying the pursuits of alchemy, was the existence of an universal matter which, endowed with various properties, forms all known substances, and consequently all the metals; in short, that a change in appearance constitutes a veritable transformation of a metal. If a fragment of iron be dropped into a solution of blue vitriol, the iron gradually disappears and in its place we find copper. We now know that the iron is dissolved and the copper contained in the vitriol precipitated; we do not regard the visibly iron-coloured metal, which is dropped into the solution, as including the same matter as the visibly copper-coloured metal which is afterwards found in its place, but in the alchemical stage of the science a totally different view prevailed, and the mythological nomenclature then used, such as Mars for iron, and Venus for copper, clearly expresses the then prevailing theory. The same material which in Mars's coat of mail appeared as iron, reappeared in the garb of Venus (as copper) after being acted upon by the vitriol.

In the sixteenth century chemistry emerged from its previous degraded condition, and passed into the hands of men who were not trammelled by the doctrines of Aristotle. The physicians who were the followers of Paracelsus paid but little respect to ancient authorities, and relied entirely upon their own observations and investigations. Three properties of matter especially excited their

attention, *viz.*:—first, that of enduring the action of fire without alteration; secondly, that of being volatilized by heat, in an unchanged condition; and thirdly, that of burning or undergoing change by fire. They assumed that an ideal something, which they called *salt*, was the cause of the property of resisting the action of fire; that another ideal, something which they termed *mercury*, was the cause of the property of volatility; and that a third substance, also ideal, and named *sulphur*, was the cause of combustibility. And as one at least of these properties occurs in every substance, their supposed causes came to be regarded as the constituent elements of all matter. If a substance were found to be combustible, it contained this ideal sulphur; if it volatilized without change, the ideal mercury was present, whilst if it left an unchanged residue, ideal salt was amongst its constituents.

These so-called elements—sulphur, mercury, and salt—the original notion of which may be traced farther back than the sixteenth century, played a most important part in the medical science of that and the seventeenth century. Physicians then believed that the health of the human body, as well as of its separate organs, depended on the combination in certain proportions of the before-mentioned elements, that disease was the result of a disturbance of these proportions, and that restoration to health was effected by their re-establishment. These applications, however, do not now immediately concern us, but they are important as indicating the gradual development of the theory that different substances differ, that is, exhibit different qualities, because they are composed of different ingredients, or of the same ingredients in different proportions; nevertheless the conception of this idea was still so crude that totally dissimilar substances, such as the incombustible portions of the most widely different bodies were all known as the salt constituent, the universally-accepted elements were purely fictitious, and that hardly any attempt was made to extract them from the substances in which they were supposed to exist.

But whilst chemists were thus busying themselves with these imaginary elements, they were also making gradual progress in the sounder recognition of the composition of a great number of substances. They discovered, for instance, that copper is present in substances which, to the eye, reveal no appearance of metallic copper, as in blue vitriol, and that vermillion contains mercury and sulphur—not the imaginary elements known by these names—but real mercury and real sulphur. Such knowledge as this steadily increased and became more prominent. Towards the end of the seventeenth century it had in fact made such progress, that the recognition of the substances which a body may be proved to contain, was considered as the only problem which chemistry should strive to solve, whilst investigations, involving the assumption of elements,

the existence of which cannot be demonstrated, and which, when more closely examined, prove to be imaginary, was regarded as a mischievous fallacy. It was Robert Boyle, who, about the year 1660, first expressed himself decidedly on this subject, and so laboured for the recognition of this truth, that we must regard it as having been established by him. From that time forth those substances only were regarded as the constituents of bodies, which could be extracted from them by analysis, or which had been added to them by synthesis, and those substances only were considered to be elements which defied all known means of analysis. Further, these chemical elements were regarded as fundamentally different kinds of matter of the simplest constitution then known.

What a contrast is exhibited between the ancient idea of the cause of difference in various forms of matter and that which obtained from the time of Boyle! If we consider these two opposite conceptions historically, and the transition from one to the other, they appear like two totally dissimilar pictures; but, like dissolving views, changing, the one into the other by slow degrees. In the first place we have the Aristotelian idea, according to which, matter itself devoid of properties, becomes endowed with characteristic qualities by the addition of properties, and forms, when invested with these properties, the various substances known in nature; then this idea passes gradually into that of the alchemists, but becomes confused in the transition, inasmuch as the differences of physical conditions and properties are no longer regarded as the only causes of variety in substances; the difference in chemical properties receives more attention, the existence of elements, the producers of such properties is assumed; and thus the path is prepared which leads to the idea of chemical composition. Then we see the Aristotelian theory gradually becoming indistinct, whilst the idea of the importance of the chemical deportment and composition of bodies assumes prominence, and at last we see clearly that the differences between the substances which nature presents to us in such overpowering numbers, or which we have ourselves formed artificially, depend upon differences in their chemical composition. The idea of *chemical composition*, which makes its first appearance indistinctly in the history of the chemistry of the middle ages, now forms the foundation of the science. In modern times a clear comprehension of it is the essential condition of all progress.

Turning to modern chemistry: we now recognize sixty-three different simple forms of matter which we term elements, and which, when combined, form all known compound substances. The dissimilarity of these elements and the difference in the modes and proportions according to which they are capable of combining, are now believed to be the causes of dissimilarity in those substances which are regarded as chemically different. Such dissimilar com-

pounds are regarded as being composed either of different materials, or of the same materials in different proportions. Tin, silver, mercury, and sulphur are regarded as fundamentally dissimilar substances; but in wood, in alcohol, in acetic acid, and in many other bodies, the same substances, *viz.* carbon, hydrogen, and oxygen, are contained in different proportions.

Until about the year 1830 it was believed that the chemical differences of bodies depended solely upon the causes just enumerated. It was supposed that the same element could only present itself in one form, endowed with one invariable set of properties, and that from the combination of the same elements in the same proportions, only one and the same substance could possibly result. But at this period facts became known which rendered this opinion untenable. At first these facts were few, and were regarded as exceptions to an essentially valid law, but their number rapidly increased, so that what had previously been considered as an invariable law was now shown to have owed its invariability to limited knowledge, and it became obviously insufficient to explain the chemical differences of bodies. Vinegar and sugar are, even from a purely chemical point of view, widely different substances, but they are composed of precisely the same elements, *viz.* carbon, hydrogen, and oxygen, combined in exactly the same proportions. An extinguished spirit-lamp, the wick of which is still red, emits an intolerably pungent smell; the very volatile liquid which is here produced and which emits this suffocating odour, has the somewhat uncouth name, aldehyde. Acetic ether, which has a delicious and refreshing smell, possesses entirely different chemical properties. Again, butyric acid, which is contained in rancid butter, and which has a most disgusting odour, is a body differing widely from aldehyde and acetic ether. Nevertheless, these three substances, which differ so markedly, both as regards chemical and physical properties, consist of the very same elements, *viz.* carbon, hydrogen, and oxygen united in precisely the same proportions.

In the case also of some elementary bodies such a variation of properties has been observed, that it would be almost impossible *à priori* to imagine that it is one and the same substance which appears in such various forms. The elementary body, phosphorus, which has been known for nearly 200 years as a soft, yellow substance, fusing easily, exceedingly inflammable, and undergoing rapid change when exposed to the air, appears also in the form of a red, brittle material, capable of enduring a high degree of heat without inflaming or undergoing any alteration, even when simultaneously exposed to the air. Again, the element oxygen, contained in large quantities in the air, which has no smell, acts upon certain substances only at a high temperature, and may remain for a long time in contact with moist silver without producing any change in the

metal; this very element, when in the condition in which it is called ozone, possesses properties as utterly different as we should expect to find only in a totally distinct substance. It is now a powerfully pungent gas, violently attacking at the common temperature the very same substances upon which ordinary oxygen has no action, and causing moist silver rapidly to become black with rust; in both these cases we perceive the existence of what appear to be different substances of undoubtedly similar composition.

Do not such facts appear to contradict the thesis advanced above as the acquisition of modern chemistry? They certainly do contradict the earlier and narrower conception of it; but they only serve to confirm the wider and more modern view, and to maintain it as the fundamental doctrine of chemistry. A few words of explanation will serve to render this clear. Science can no longer dispense with the hypothesis, that bodies consist of very small ultimate particles, which cannot be further divided without the production of something totally different from the matter subjected to this division. These homogeneous particles, of which a substance is built up, are called the physical atoms or *molecules* of that substance. A piece of copper is composed of copper molecules, the smallest perceptible quantity of oxygen or alcohol, of oxygen or alcohol molecules. A distinction is made between the molecules of bodies, *i.e.* the smallest particles which can be conceived as capable of independent existence, and *atoms*, *i.e.* the smallest particles which can enter into a chemical compound or contribute to the formation of a molecule. The molecules are composed of atoms. The molecules of compound bodies are composed of dissimilar atoms, atoms of different elements, whilst we assume that the molecules of undecomposable bodies—of elements—are built up entirely of the same kind of atoms. We have no knowledge of the absolute number of atoms which unite to form the molecules of different substances, whether a copper molecule, for instance, consists of 2 or 10 or 100 atoms of copper. But we do know or at least we can form very probable conjectures concerning the proportion in which the atoms unite to form a molecule; for instance, in what proportion the carbon, hydrogen, and oxygen atoms are combined in a molecule of alcohol, or what is the proportion between the number of oxygen atoms contained on the one hand in a molecule of alcohol, and on the other in a molecule of common oxygen.

It will now be apparent how the different conditions of the same elementary substance may depend upon differences in its composition. The same elementary atoms may obviously, by combining in different numbers to form molecules, give rise to dissimilar molecules. We know with almost absolute certainty that a greater number of oxygen atoms is contained in a molecule of ozone than in a molecule of ordinary oxygen. We can assume with great

probability that the number of oxygen atoms in a molecule of ozone stands to the number in a molecule of ordinary oxygen in the proportion of three to two. Thus, ozone and ordinary oxygen consist of molecules, the composition of which differs, not in respect of the quality but of the number of atoms which they contain. Imagine the oxygen atoms as so many soldiers belonging to one army, although this comparison be a rough one, it is not so inappropriate as might be imagined; for in fact, in chemical action, these atoms do fight against the alliance between other kinds of atoms, and must vanquish their opposition before they can take up and maintain new positions. A certain weight of oxygen consists of an unspecified number of these atoms or soldiers; but in equal weights of ordinary and of ozonized oxygen, the same number is arranged in a different manner. A given weight of common oxygen contains a certain number of these atoms or warriors, which are marshalled in a certain number of battalions or molecules; an equal weight of ozone contains the same number of exactly similar atoms or warriors, which are, however, placed in a smaller number of molecules or battalions. A molecule of ozone is numerically a stronger battalion than a molecule of oxygen. By the help of this crude simile, it is easy to understand how the same element can pass from one of these conditions into the other, and how, according to the different marshalling of the said atoms, the same element may have different chemical effects upon other bodies—may attack the molecules or battalions of which they consist in a different manner.

The explanation just offered of the possibility of similar atoms being arranged in different kinds of molecules, is manifestly applicable also to dissimilar atoms. Imagine different kinds of elementary atoms—carbon, hydrogen, oxygen atoms for instance, to be represented by different kinds of soldiers, as infantry, cavalry, riflemen. Equal weights of acetic acid and sugar contain the same quantities of carbon, hydrogen, and oxygen, *i.e.* the same number of atoms of the three elements, or of warriors of the three different arms. But the arrangement of these warriors in military order—in battalions or regiments—is dissimilar in the two bodies. A molecule of sugar contains a greater number (at least thrice, perhaps six times as great) of atoms of carbon, hydrogen, and oxygen as a molecule of acetic acid. Although the composition of acetic acid is identical with that of sugar, both as regards quantity and quality of the contained elements, yet the molecules of the two substances are of dissimilar formation, *i.e.* they contain the same elementary atoms in different numbers though in the same proportions, and we know with still greater certainty that in aldehyde, only half as many atoms of carbon, hydrogen, and oxygen are united to form a molecule, as in acetic ether or butyric acid, which in all other respects have exactly the same composition, containing the same elements in the same proportions.

But what is the cause of the difference between the two last-named substances—butyric acid and acetic ether, the molecules of which consist of equal numbers of the same kinds of atoms? Obviously the atoms contained in a molecule may differ, not only in number and quality, but also in the mode in which they are grouped together. To employ the simile once more, the battalions are divided into companies, and it is evident that this mode of division may differ, whilst the number and kind of elementary atoms remain the same. Two battalions containing equal numbers of warriors of three kinds and in like proportions may have very different internal formations. The soldiers of each class may, for instance, be massed in separate companies, or they may be mingled indiscriminately throughout the whole battalion; again, the number of companies and the mode in which the different classes of warriors are arranged may differ widely in the two battalions. These differences of internal arrangement may greatly affect their respective aggressive movements and powers of resistance, and when the battalion is vanquished and dispersed, its previous formation will affect the combinations which may be formed from its fragments.

Thus, even in modern chemistry, the fundamental idea that the varieties of matter depend upon differences of chemical composition, is still maintained, although not precisely in the same sense in which it was understood forty years ago; its scope is wider, and it has received new developments in special directions. Pure chemistry—as distinguished from its technical applications—is at present occupied with the working out of this idea in the most varied directions. The different bodies found in nature are being interrogated with the view of ascertaining if any description of atom can be found which has not hitherto been met with, and to render the list of elementary substances more complete, new and more searching methods of investigation are being devised, in order to discover any kind of matter which has hitherto remained hidden or unnoticed. Many laws relating to the method of arrangement of the elementary atoms in molecules have been already discovered, and the existence of others foreshadowed. Certain peculiarities of the different kinds of elementary atoms are becoming more and more apparent—for instance, that some will enter in couples only into the composition of a molecule, and that elementary atoms present different numbers of sides, so to speak, for the attachment of other atoms. How the elementary atoms are grouped into the proximate constituents of various complex substances, and how certain chemical properties, such as those of acids, depend upon a special arrangement of atoms; these are examples of the problems which are now being assiduously investigated. Also the dependence of many of the physical properties of substances on their chemical composition, in the widest sense of the term, has been proved, and has been the subject of continual investigation, resulting in ever-extending knowledge. The

FIG. 1

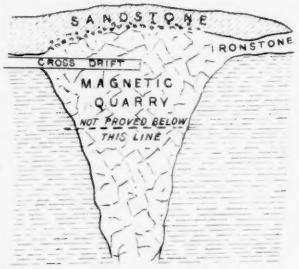


FIG. 2.

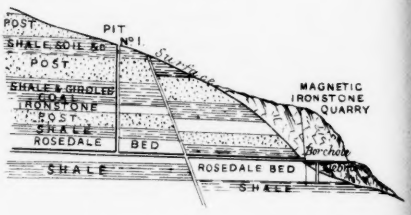


FIG. 3.

FIG. 4.

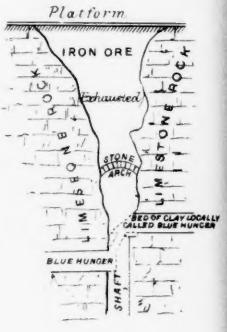


FIG. 5

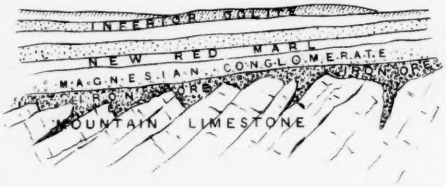


FIG. 6

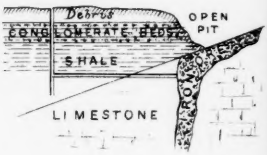


FIG. 7

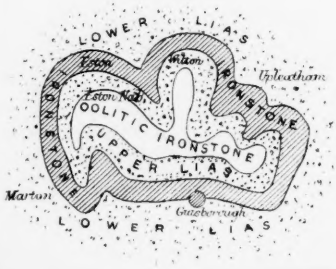
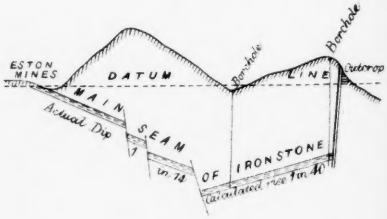


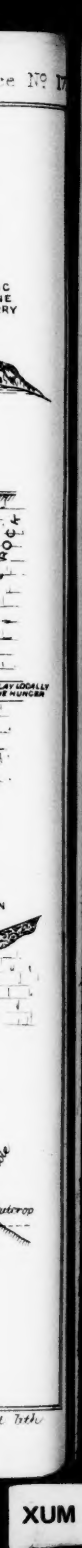
FIG 8.



J.B. Jordan del.

Mc.N. Hardcastle lith.

BRITISH IRON FORMATIONS.



limits of this article prohibit the further pursuit of the ideas which guide modern chemists in their investigations, but we have followed these latest developments sufficiently to show that, notwithstanding their widely-different aspects, one and the same leading idea underlies the chemistry both of the past and of the present.

V. THE IRON ORES OF GREAT BRITAIN.

By Robert Hunt, F.R.S., Keeper of Mining Records.

In the year 1866 more than ten million tons of Iron ores were submitted to the action of fire in 613 blast furnaces, and from them we obtained about four millions and a half tons of Pig Iron. The great importance of these minerals, regarding them merely as sources from which we draw the material for the manufacture of our almost infinite variety of machines and tools, our rails, our armour-plates, and nearly every description of implement and cutting instrument, necessarily renders any examination of the phenomena connected with their occurrence in Nature of considerable interest. We find Iron disseminated through every rock, and in various conditions of aggregation in almost every geological formation, playing often a very important part in giving character to the mass. Indeed, the fact that this metal is found in each of the three Kingdoms of Nature indicates some especial function, which is not yet clearly appreciated, of equal importance in the organic and the inorganic worlds. It is, however, only with the occurrence of Iron in rock-masses that this paper will deal. It is intended especially to examine the peculiar conditions under which some of the varieties of Iron ores occur, and to discuss the circumstances which probably attended the formation of many of our ferruginous deposits, whether occuring as nodular concretions, intercalated with our coal-beds, as crystalline mineral forming lodes in the older rocks, or as sedimentary beds, spread over wide areas of very different geological ages.

The following list gives the varieties of commercial Iron ores produced and used in this country, showing the average percentage yield of Iron of each variety, and the proportions in which they are employed in the Iron manufactures of these Islands:—

	Per cent. of Iron.	Proportions in which used.
Red Hæmatite	65·13	15 per cent.
Magnetic Oxide	56·10	2 ,,
Brown Hæmatite	41·40	13 ,,
Ditto Ditto (*Oolitic*) ..	35·60	26 ,,
Spathose Ores	40·95	2 ,,
Black Band	37· 8	42 ,,
Argillaceous Ores	30·68	
Mean average of all, if used in equal quantities ..	47·30	100 ,,

In attempting any classification of Iron ores which shall be regulated by the conditions under which they are found, we are at once met with the difficulty of finding many similar varieties of ores occurring in lodes or veins, and also amongst those which are evidently sedimentary deposits. It will not, therefore, be attempted. There can be no doubt that the most ancient of the Iron formations are those Oxides of Iron which occur as lodes or veins in the slate and granite rocks. Of this kind we have some examples in Cornwall, Devonshire, Wales, and Scotland. Generally speaking, however, these veins are not sufficiently extensive to be worked. The Iron Mine at Restormel, near Lostwithiel, in Cornwall, which has been wrought for many years, and which still produces considerable quantities of ore, and those near St. Austell, in the same county, are amongst the most remarkable. At Hennock, on Dartmoor, there occurs an immense vein of Micaceous Iron ore, but this of late years has not been employed. All these are evidently the result of the aggregation of ferruginous particles, often under the influence of crystallogenic force, mechanically separated from water holding iron in solution, which has flowed through the rock fissures probably within a limited period after the formation of those fissures. The Iron lodes differ in no respect from those of the other metals, except in the nature of their contents, and they have been formed under analogous conditions, all of them indicating the influences of an elevated temperature, of an electrical disposing power, and those mechanical agencies which are still obscure, but which are being gradually developed under the general appellation of Osmose forces.

Magnetic Iron Ores.—Magnetic Oxide of Iron or Magnetite is a compound ore of the Sesquioxide of Iron and the Protoxide of Iron. Amongst other adventitious matters, this ore usually contains manganese and sometimes tin. In Western England several lodes of magnetite are known, one near Penryn and another not far from St. Austell, in Cornwall, has been worked, but not extensively. Near the Haytor rocks, on Dartmoor, a much more extensive deposit of this ore is found; but it is difficult in this case to determine satisfactorily, whether this is a set of veins or of beds interstratified with slate and sheeted masses of greenstone porphyry. At Brent, which is only a few miles distant from the Dartmoor deposit, we find magnetic ore covering, like a shell, an immense boss of trappean rock. In nearly all cases, magnetite is associated with, or is found in proximity to, some igneous rock, and to the action of this on either Oxide or Carbonate of Iron is no doubt due the magnetic character which distinguishes this ore. If the Spathic Carbonate is exposed to a regulated heat, it is converted into a Magnetic Oxide of Iron, and manufactories have been established for its production, to be used as a paint for work which is much exposed to the action of the weather.

A curious mass of Magnetic Iron ore occurred at Rosedale, in Yorkshire. The first discovery of this deposit of Iron-stone was at a quarry on the south-west side of the valley of Rosedale, about a mile south from Rosedale Abbey. When this quarry was opened out, it was found apparently to consist of a confused mass of iron-stone boulders, of an ellipsoidal structure, often three or four feet in diameter. The interior of these boulders was generally blue, and comprised a solid dark oolitic iron ore, with, in many cases, sandy and solid crusts around it; and in receding from the centre the iron ore became paler, alternating with dark-brown purplish layers. Those variations did not occur where the iron-stone was covered by other strata, and the magnetic property proved to be most decided where the mass was the thickest. These circumstances appear to indicate that this mass was at one time in the state of a Carbonate of the Protoxide of Iron, not very unlike that which occurs in the Cleveland Hills, but that it had been exposed to influences—not necessarily calorific—by which the chemical change into Magnetite had been effected. This ore especially resembles the hydrated Magnetic Oxide of Iron, which can be obtained as a precipitate from an aqueous solution. Figures 1 and 2 in the Plate will explain more fully than any words the peculiar conditions of this remarkable and valuable Iron ore formation. The first section is by the late Mr. Nicholas Wood, the second by Mr. Bewick. It should be noted that the latter observer, writing of this deposit, says, "The Iron ore of Rosedale, instead of being a large mineral field, as was first asserted, and still believed to be so by many, is nothing more than a volcanic dyke; and the iron-stone opened out in this locality is not, as it is reputed to be, the main seam now being worked in Cleveland and Grosmont." The Magnetic Oxide of Iron has been discovered in Banffshire, Aberdeenshire, the Shetland Islands, and the Hebrides. It occurs also in Antrim, in Wicklow, and especially in the Mourne Mountains.

Red Hæmatite.—The deposits of this valuable ore—an anhydrous Sesquioxide of Iron,—which are found in Furness near Ulverstone, and near Whitehaven, are deserving of the closest attention. At Whitehaven, this ore is found in the carboniferous limestone and millstone grit (locally called "Whirlstone") near the outcrop or surface edges of the slaty rocks upon which these formations rest. Fig. 3 shows the mode of occurrence. At Todholes, where this ore was worked as a quarry, the bed had a thickness of twenty feet, and at the Park Mines a thickness of seventy feet of solid Hæmatite occurred.

The Ulverstone ore differs in physical condition from those of Whitehaven. Much of it is equally compact with the Cumberland ore, and this is known as "blast" ore; but the major portion occurs as a less coherent aggregate of exceedingly fine filmy scales of mica-

ceous iron. In the Whitehaven district the ore is found filling cavernous spaces, which had evidently been formed in the limestone previously to the deposit of the Iron; these caverns being probably due to the action of water charged with carbonic acid, which readily dissolved a certain proportion of the limestone. In the Low Furness district, at Rickett Hills, and Mousell, the Hæmatite is found in lake-like deposits, which have been well described as "dish-shaped." These dishes of ore run from fifty to sixty yards in width, and are usually from eighteen to twenty feet deep. At Roanhead the ore is found in two basins, which are slightly connected with each other, but they have nothing of the character of a mineral lode. These basins are covered generally with sea-sand, which is often overlaid with a tenaceous clay. Nothing like a mineral lode occurs either at Whitehaven or at Ulverstone. At Stainton, a chasm worked open to day was long looked upon as a vein of ore, but the full exploration of it proved the contrary. Fig. 4 is a section of this chasm, which was worked altogether to the depth of sixty yards. The stone arch shown was built to support the walls of the fissure, it being thought that the ore would be found to a considerable depth below. Within a short distance a bed of clay, locally called "blue hunger," came in, below which there was not a trace of Iron ore.

Brown Hæmatite.—The Forest of Dean may be regarded as the chief locality for this variety of Iron ore, about 150,000 tons being raised annually. The Forest of Dean ores are commercially classified into *Brush Ore,* containing 90 per cent. of Sesquioxide of Iron; *Smith Mine* giving 89 per cent., and *Clod* or *Grey Vein* about 50 per cent. These iron ores occur under much the same circumstances as the Red Hæmatites of Whitehaven. The iron-stone formation is immediately overlaid by the "Whitehead Lime-stone," a regularly stratified rock, the beds of which are often highly crystalline. This limestone is locally called "crease," and is traversed by innumerable small joints, which appear to have arisen from a shrinking, probably during the consolidation of the mass. The worked-out spaces in the "Mine Measures," that is,—the iron-stone beds which have an average thickness of twenty-five yards,—are so extensive that they have been compared to the crypt of a cathedral. These prove the deposit to have taken place in caverns which had been previously formed by the removal of the limestone. There are many curious phenomena connected with the Iron ore formations of the Forest of Dean, which demand a careful examination. It is not, however, possible in this place to give the required consideration to those, since the space which can be allowed to this article is fully occupied, with the general review of our iron-stone deposits, and remarks on the conditions under which they appear to have been formed.

Some valuable deposits have been recently worked in Gla-

morganshire. The Iron ore deposits at Llantrissant, which have only of late years attracted marked attention, appear to have been worked at least two centuries since. The name of the principal mine is Mwyndy, and this is derived from the estate in which the mineral is found. The word signifies Ore, therefore Mwyndy House is "Ore House," and around it in all directions we now find Iron slag and remains of the charcoal with which it was once smelted. This Iron ore, which is now worked by two companies only, "*The Mwyndy Iron Ore Company*," and "*The Bute Hæmatite Company*," partakes in its general character of the ordinary conditions of the Brown Hæmatites. Its situation is similar to that of the Whitehaven Red Hæmatite, and it does not appear in this respect to differ from the ferruginous deposits of the Forest of Dean. It occurs at, or rather immediately beyond, the southern outcrop of the Coal Measures of South Wales. Between the coal seams immediately south of the village of Llantrissant and these Iron ore deposits, the Permian rocks occur, these being represented more especially by large masses of Conglomerate. It will be seen by the section given (Fig. 5), that we have conglomerate and shale rocks resting on the limestone formation, which here forms the boundary of the South Wales coal basin. Under the conglomerate and coal measure shale, in which some thin bands of coal occur, the Iron ore is deposited on the upturned edges of the limestone, and in the fissures formed in that rock. It has been thought hitherto that the ore would be found only at the line of inclination of the limestone, but a recent discovery has shown that it suddenly descends into the limestone itself. This vertical mass of ore (Fig. 6) may be found to terminate abruptly, as shown in the Ulverstone section, or it may lead to a limestone cavern which has been filled in with this peroxide of iron. In the immediate neighbourhood of this deposit a small band of argillaceous nodular iron has been discovered.

At Frampton Cotterel, in the Bristol Coal-field we find the Brown Hæmatite occurring in the Pennant Grit, or sandstone bed of the coal-measures. This iron ore deposit has been formed in a great fault, evidently under similar conditions to those which have regulated the deposits already named, in the limestone.

Numerous deposits of Brown Iron ore exist in Cornwall and Devonshire. Near St. Austell in the former county, and near Brixham and Newton Abbot in the latter, these ores are worked with success. The Brown Hæmatites of North Wales and other districts have not as yet attracted much attention. A very remarkable calciferous Brown Hæmatite occurs at Froghall, near Cheadle, in North Staffordshire, which is largely used in the iron works of South Staffordshire. This ore, which occurs in the lower coal measures, may probably be regarded as an altered highly ferruginous limestone.

The Brown Hæmatites of the Oolites must be considered as Hydrous Sesquioxides of Iron; they are in nearly all respects peculiarly distinguished from those ores of which notice has been already taken. The Northamptonshire and Lincolnshire Iron ore deposits especially represent this class; they are continued, with various shades of difference, through the adjoining counties.

The first impression on examining the various beds of Iron ore, which we can now trace from near the Humber to within a few miles of Oxford, will be, that they are the result of deposit from water, as peroxide of Iron, in the same way as we see ferruginous springs depositing—as the water is exposed to the air—the Iron which they hold in solution. This hypothesis supposes those beds to be of recent formation. After, however, a careful examination of all the evidences afforded by the fossil remains which exist in those beds, and in other beds above and below the ferruginous ores, no other conclusion can be arrived at, than that they are of very different ages, the result of a recurrence of the same conditions, but all of a marine origin.

Spathose Iron Ores, Sparry Carbonate of Iron.—These ores of Iron have been long selected for the production of the celebrated "steel irons" of Siegen, Styria, and Carinthia, consequently of late years they have been sought after in this country.

Mr. Charles Attwood, to whom we are especially indebted for a knowledge of the Spathose Iron ores of Weardale, notices the same conditions as those found in other districts. They have certainly been all at first deposited as carbonates more or less pure, and have passed into the state of oxides and hydrates, by the joint effects of atmospheric and of aqueous action. Examples of every stage of the transition present themselves in all directions, and there are also met with, from time to time, abundant proofs that whilst the carbonates deposited are more or less rapidly passing into the hydrated condition, a fresh deposit of carbonates is continually going on in the cavernous interstices, and on the roofs and sides of ancient workings. Upon one occasion Mr. Attwood found protruding for six inches from a block of pure and large grained Sparry carbonate of iron, *a rod of malleable iron,* of about a quarter of an inch in diameter, of which the other end was firmly embedded to about the same depth in the block, which had just before been broken from a mass of it, incrusting the walls and roof of an ancient drift, but which block must have been formed within one or two centuries. Mr. W. W. Smyth remarks, "When we look to the successive introduction of the various minerals which have filled these interesting veins, it is evident that the carbonate of Iron has been one of the latest comers. Many of the specimens exhibit it, investing, as a crystalline incrustation, the previously formed crystals of fluor spar and galena; and the striking manner in which it is

found to coat only those surfaces which face in a peculiar direction, is well worthy of attention in the study of these obscure phenomena." Besides the Spathose ores of Weardale, we have the same ores occurring in great abundance on Exmoor, and they are worked extensively on the Brendon Hills, near Watchet, over a length of nine miles, to Eisen Hill. At Perranzabulæ, on the north coast of Cornwall, a still more remarkable deposit of these ores exists, but at the present time they are but slightly worked. In the northern corner of Perran Bay a lode appears in the cliff, with a width of nearly 100 feet, and it has been traced for some miles inland and worked at several points. Beyond this brief notice, space cannot be given to the further consideration of these most interesting Iron ores.

The Argillaceous Iron Ores of the Lias.—The Cleveland Iron ore is the finest example we have of this class of ore. The immense extent of this deposit, the value of the Iron works which have arisen amidst the Cleveland Hills, places this district amongst the first of our Iron-producing districts.

This remarkable deposit may be traced by its outcrop for miles along the escarpments of the Cleveland Hills. Above the flat land which extends from Redcar to Middlesborough there crops out a solid stratum, often fifteen feet in thickness, of this Iron-stone. It is a deposit of a green or grey colour, having generally an oolitic structure, and containing numerous well-known fossils of the Marlstone, especially *Belemnites* and *Pecten Æquivalis*. The plan and section, Figs. 7 and 8, will show the mode of occurrence of this ore. This vast ferruginous deposit is composed, to a great extent, of Carbonate of Protoxide of Iron. We know that such a deposit could not be formed, unless it was precipitated from water charged with Carbonic acid in excess. We have no evidence that such conditions ever prevailed, to the required extent, over this district, when those Iron-stone beds were being formed. Mr. Sorby has drawn attention to the fact that if the Iron-stone be examined it will be seen that it contains, more or less, entire portions of shells. All the indications appear to show that the Cleveland Iron ore was deposited probably as a limestone, containing a large amount of the oxides of Iron and organic matter. By their mutual reaction these would give rise to the bicarbonate of Iron, which in solution, percolating through the limestone, would remove a large part of the carbonate of lime and leave in its place carbonate of Iron.

It is our object in writing this paper, to draw more especial attention than has hitherto been done to the Hæmatites, and the Argillaceous Carbonates of the coal-measures, as related to each other, in their mode of formation.

It will be evident to everyone who carefully studies the conditions of the clay band Iron-stones spread out in beds amongst the seams

of coal and coally shale, that they have been associated in some way with the formation of the coal itself. As the coal deposits have been produced by a series of chemical changes in vegetable matter, spread over an immensity of time, so have the Iron-ore deposits, as we find them, been the result of sundry changes carried out upon the older rocks, those especially which belong to the Devonian or Old Red Sandstone period. The enormous deposits of Sandstones and Shales formed in our coal basins prove the gigantic nature of the denudations which have taken place, and which have produced the sedimentary beds, as they are placed before us, striking records of the world's mutations. From all that remains of those older rocks we know how highly ferruginous they were. The waters of the coal period swept around Old Red Sandstone rocks, and the plants from which our fossil fuel is derived grew upon the soil produced by the disintegration of these formations.

Let us study for awhile the phenomena which, in all probability, took place. As we now find at the mouths of great rivers,—especially within the tropics,—vast masses of vegetable matter, undergoing a series of changes, in the process of decay, so must we suppose the condition of a swamp, of an estuary, a lake, or inland sea, to have been, when the vegetable matter of an ancient world was *rotting*, in its progress towards coal. The result of the change was the formation of immense quantities of carbonic acid, and this would be largely retained by the water holding vegetable extractive in solution. This water would rapidly dissolve any limestone with which it came in contact, and would change the peroxide of Iron in the rocks into a protoxide; which would be eventually dissolved, either as a carbonate of the protoxide of Iron, or in water holding an excess of carbonic acid, as a protoxide merely. Experiment shows this satisfactorily. Place recently precipitated peroxide of Iron in a shallow vessel with a large quantity of dead leaves and water; expose this to the ordinary atmospheric changes; it will be found eventually, that the peroxide will be changed into a protoxide and dissolved. Under some conditions,—especially if the arrangement is made part of a voltaic circuit,—crystals of carbonate of Iron will be the result; and under others an accretion of amorphous carbonate will form around small fragments of vegetable matter, producing indeed, in miniature, the clay-band Iron-stones of the coal measures.

Now, if the water flows away from the influence of this mass of vegetable matter in its state of change, and if it be exposed in a thin sheet, to the action of the atmosphere, the Iron in solution will be rapidly oxidized and it will fall to the bottom of the vessel as peroxide of Iron.

These results appear to teach us that the present conditions of

our coal measure Ironstone formations were the direct result of the process of coal formation, the water in which the coal was formed removing from the surrounding rocks, by virtue of the dissolving power of carbonic acid, the Iron which they contained; this, if retained within the coal basin, gradually produced the argillaceous carbonates of Iron as we find them, but if the ferruginous waters passed away from the influence of the dissolved vegetable matter, then oxidation ensued, and hence the deposits of Hæmatite in ponds and fissures as we see them near Ulverstone. The same carbonized water had previously been active in dissolving the limestones formed around the coal basins, and into the cavernous spaces thus formed,—and these are common in all our carboniferous limestone districts —the peroxide of Iron was deposited, as at Whitehaven, in the Forest of Dean, and in Glamorganshire.

Further study is required before it can be certainly determined whether or not the chemical changes indicated, are those only which have been active in producing our Iron ores as we now find them. It is, however, believed that the hypothesis put forward will serve to explain most of the conditions which are presented to the careful observer. They are, at least, honest attempts to read the phenomena which are presented to us in the varied conditions under which we find the most useful of the metals, Iron, occurring in the inorganic world.

VI. ON MEDICAL SCIENCE: ITS RECENT PROGRESS AND PRESENT CONDITION.

The season which has passed away, although not especially fertile in the fruits of the earth, has not been deficient in those of the mind. The intellectual harvest, gathered at the autumnal meetings of learned and scientific societies, at statistical congresses, and other assemblages of men earnestly engaged in the pursuit of common objects, has been plentiful and of perhaps more than average quality. We have already registered many of these products, but there is one class of them, which, from its purely technical nature and the unfitness of many of its details for public discussion, is rarely noticed, except in Journals strictly professional; and yet it relates to matters in which we are all deeply interested. If there is any subject which "comes home to our business and bosoms," it is that of Medicine. Next in importance to the supply of our daily wants of food and clothing, is the care of our health, and the improvement of the means of its conservation is a topic to which none of us can be indifferent; an occasional survey, therefore, of the

condition of Medical Science, free from objectionable details, may fitly find a place in a Journal designed for general circulation.*

We have before us the papers read at the Dublin meeting of the British Medical Association, the communications to various provincial meetings of the same body, contributions to the Journals, and last, but by no means least in value, the addresses delivered at the opening of the winter session at the different medical schools, metropolitan and provincial. The conclusion to be drawn from these various sources of information as to the recent progress and present condition of Medical Science is a most encouraging one. In no former period of equal length have such advances been made as in the last half-century in the detection of diseased action or morbid change, and if equal progress has not been made in the Art of Medicine, in the application of Science to the prevention of death or the relief of suffering, still even in that respect the advances have been immense. The practitioner now undertakes with confidence the treatment of diseases which his predecessors regarded as incurable, and the modes of treatment have, in many instances, been simplified and made less painful.

A recapitulation of some of the additions thus made to the means of combating disease ought to be specially interesting to the readers of a Journal like ours, for it has been strictly and exclusively by the means of research furnished by experimental science, that our knowledge of disease has been extended, and if wise empiricism, or happy imagining (the inspiration of genius), has, rather than scientific research, furnished the improved methods of treatment, Science has provided the means of utilizing the thoughts thus suggested.

But leaving these generalizations, let us proceed to a few details, and first of the improved methods of research. Of these the foremost has been the extension of the power of vision by the microscope. The additions to our stores of knowledge, both of healthy structure and of morbid changes, thus acquired, would fill volumes; and we have not space for the enumeration of even a few of them.

Next, in point of value, should be placed the discovery which to some extent does for the sense of hearing what the microscope

* We think it right to say that, in making such a survey, we take as our guide and as a sketch-map of the country over which we intend to travel, an address recently delivered before the North Wales branch of the British Medical Association, by its president, Mr. Thomas Eyton Jones, of Wrexham. In choosing such a guide, we are not alone influenced by the intrinsic merits of the address, as a lucid and comprehensive abstract of the recent progress of medicine, but we have pleasure in showing that not only in our great cities, the centres of mental activity, is medical science studied with earnestness, but that the men living in remote provincial towns, and practising among widely scattered populations, are able to keep pace with, and to rival their more favourably situated brethren.

does for the sight. We know not who first applied his ear to the walls of the chest, to endeavour to learn, from the sounds thence emitted, the variations in the action and conditions of the organs therein contained; but he who first thought of interposing between the ear and the naked body a tube of some unyielding material, and thus made mediate auscultation an universally applicable mode of research, deserved to be ranked among the greatest benefactors to mankind. And an equal rank should be given to the inventor of percussion as a mode of examination, the man who first showed that by close attention to the varied quality of the sounds produced by a smart blow on the walls of the chest, most precious knowledge might be obtained of the condition of the contained viscera.

The sense of touch also has not been without its cultivators. The *tactus eruditus* has long been one of the most highly valued accomplishments of the surgeon, but improved methods of palpation have made it almost equally useful to the physician; and most valuable additions have recently been made to the information which the touch gives as to the pulse. The knowledge gained by gentle pressure with the tips of the fingers on a superficial artery, of the frequency, force, and other qualities of the action of the organs of the circulation, is necessarily uncertain, because it is subjective knowledge, and because therefore the accuracy of the observations must depend on the carefulness and experience of the observer, and the delicacy of his sense of touch. A beautifully imagined instrument now registers for us the pulsations, and describes on paper the height, form, and other qualities of each arterial wave. We must also regard as helps to the sense of touch the improved modes of applying the thermometer to the surface and the cavities of the body. Most precious knowledge is thus acquired as to the progress of febrile and inflammatory diseases, and our powers both of prognosis and of diagnosis have been immensely increased.

To all these modes of rendering medicine more and more one of the exact sciences, must be added the improved modes of research furnished by chemistry. Our knowledge of the composition of organic bodies, and of the chemical changes constituting assimilation and degeneration, and of the processes of growth, secretion, and excretion, has only within the last quarter of a century acquired anything like the character of certainty. The physiological chemist has not only entered so far into the *arcana* of Nature as to be able to ascertain, to a great extent, how she does her work, but has even succeeded in imitating her operations. Not content with analysis, he has with considerable success attempted synthesis also. "Already he has been able to produce a large number of organic compounds from carbonic acid, water, and ammonia, and even from the pure elements themselves. In fact, of the three great classes of alimentary substances, the production of the oleaginous is quite

within his reach; that of the saccharine is almost within it; but the albuminous is still beyond."*

The application of such researches as these to the Science of Medicine is too obvious to need pointing out. They furnish the only safe basis on which the knowledge of diseased actions and of morbid poisons can be founded. To the latter class of bodies, owing to the unusual prevalence of infectious diseases, special attention has recently been paid, and we seem to be on the eve of brilliant discoveries in reference to some of them. The question is still unsolved whether the poison, or *contagium*, of the so-called Zymoses, consists of living germs, *i.e.* entire, although undeveloped, organisms, or of living portions of organic matters, *i.e.* germinal particles or cells, or of dead matter, peculiarly compounded, and undergoing some special process of decomposition.

For a further extension of our power of research into the chemical constitution of organic bodies, we are indebted to a new application of the Science of Optics. Spectrum analysis now not only tells us of what elements the planets and the photosphere of the sun are composed, but whether certain red spots which may be the subject of medico-legal inquiry, are or are not stains of blood. For this great discovery we have to thank Mr. Sorby, of Sheffield. Dr. Bird Herapath, of Bristol, was the first to employ it in the inquiry into a case of alleged murder. It is impossible in imagination to limit the extent to which micro-spectroscopy may aid us in the analysis of organic bodies.

One of the latest applications of physical science to the purposes of medicine is a further extension of the powers of sight. Endoscopy, in its various forms, by most ingenious combinations of lenses, mirrors, tubes, and, in some instances, increased means of illumination, enables us now to explore all the canals opening on the surface of the body, and even to inspect some of its cavities. The revelations thus made are wonderful, and have far exceeded the expectations of those who first suggested such means of research. It might have been expected that, looking through the window of the Cornea, we might ascertain the exact condition of the internal structures of the eyeball. But who would have imagined that from the morbid changes observed in them we might be able to pronounce with certainty on the existence and nature of disease existing, not only in the brain, but in so remote an organ as the kidney? An amusing instance of the enthusiasm with which this line of inquiry is now pursued was given at the international medical congress which recently sat in Paris. A zealous worker in the field of endoscopy foretold the time when, by means of the lime-light, the whole body

* Dr. Letheby's Introductory Lecture at the London Hospital.—*British Medical Journal*, Oct. 5, 1867.

would be rendered diaphanous, and morbid changes be detected in its innermost recesses.

But our space will not permit us to linger in this tempting field, and we pass on to notice a very few of the latest improvements in the Art of Medicine. If asked to indicate the one quality which characterizes the present race of practitioners as compared with the majority of their predecessors, we should say that it is conscientiousness, shown by increased reverence for the human body, and a greater wish to diminish pain or to avoid its infliction. Surgery has become eminently conservative. The man is not now most admired by his brethren who performs in the most dashing style the capital operations of surgery. It is almost universally felt that such operations, being more or less serious mutilations, are, in the same ratio, confessions of the imperfection of the art. He is not now liable to be sneered at, as he was within our recollection, who professes greater pride in the preservation of a finger than in the amputation of an entire limb. Modern surgery thinks it no condescension to labour in the removal, not of disabling deformities only, but of disfigurements and blemishes, and by various plastic operations to endeavour to restore to "the human form divine" its pristine beauty, lost by accident or disease. Many of these triumphs of conservative surgery would, because of their tedious and therefore additionally painful nature, have been impracticable but for the grandest discovery ever made in relation to the art of medicine, that, *viz.* of a safe and easy method of producing temporary unconsciousness of pain. If there be one invention of human genius worthy to be called an anticipation of the millennium, it is that of anæsthetics. To say nothing of the preservation of life, the amount of agony from which mankind has thus been saved is incalculable.

This topic, the avoidance of suffering in surgical operations, is one of such surpassing interest to humanity that we are tempted to enlarge upon it a little. Nearly a quarter of a century has elapsed since the introduction into practice of the use of anæsthetics, and of the present generation few are conscious, from their own experience or observation, of the magnitude of the boon; and this may be said even of the large majority of surgeons now in practice. We will, therefore, extract from a work not likely to be read except by professional persons, and written by one who has done more than any other man living to bring about this blessed change, Sir James Simpson, a description by a master in the art of composition, the late Professor George Wilson, of Edinburgh, of the horrors of a surgical operation under the old mode of treatment.

"Several years ago," Professor Wilson writes in a letter to Sir James Simpson, "I was required to prepare, on very short warning, for the loss of a limb by amputation . . . I at once agreed to submit to the operation, but asked a week to prepare for it;

not with the slightest expectation that the disease would take a favourable turn in the interval, or that the anticipated horrors of the operation would become less appalling by reflection upon them, but simply because it was so probable that the operation would be followed by a fatal issue, that I wished to prepare for death and what lies beyond it whilst my faculties were clear and my emotions comparatively undisturbed. . . .

"The week, so slow and yet so swift in its passage, at length came to an end, and the morning of the operation arrived. . .

"Before the days of anæsthetics, a patient preparing for an operation was like a condemned criminal preparing for execution. He counted the days till the appointed day came. He counted the hours of that day until the appointed hour came. He listened for the echo, in the street, of the surgeon's carriage. He watched for his pull at the door-bell; for his foot on the stairs; for his step in the room; for the production of his dreaded instruments; for his few grave words, and his last preparations before beginning; and then he surrendered his liberty, and, revolting at the necessity, submitted to be held or bound, and helplessly gave himself up to the cruel knife. The excitement, disquiet, and exhaustion thus occasioned could not but greatly aggravate the evil effects of the operation upon a frame predisposed to magnify, not to repel, its severity. To make a patient incognisant of the surgeon's proceedings, and unable to recall the details of an operation, is assuredly to save him from much present and much future self-torture, and to give him a much greater chance of recovery. . . .

"The operation was a more tedious one than some involving much greater mutilation. It necessitated cruel cutting through inflamed and morbidly sensitive parts, and could not be despatched by a few swift strokes of the knife. . . .

"Of the agony it occasioned I will say little. Suffering so great as I underwent cannot be expressed in words, and thus fortunately cannot be recalled. The particular pangs are now forgotten; but the black whirlwind of emotion, the horror of great darkness, and the sense of desertion by God and man, bordering closely upon despair, which swept through my mind and overwhelmed my heart, I can never forget, however gladly I would do so. . . .

"During the operation, in spite of the pain it occasioned, my senses were preternaturally acute. . . . I watched all that the surgeons did with a fascinated intensity. I still recall with unwelcome vividness the spreading out of the instruments; the twisting of the tourniquet; the first incision; the fingering of the sawed bone; the sponge pressed on the flap; the tying of the blood-vessels; the stitching of the skin; and the bloody dismembered limb lying on the floor.

"These are not pleasant remembrances. For a long time they

haunted me, and even now they are easily resuscitated; and though they cannot bring back the suffering attending the events which gave them a place in my memory, they can occasion a suffering of their own, and be the cause of a disquiet which favours neither mental nor bodily health. From memories of this kind those subjects of operations who receive chloroform are of course free; and could I even *now*, by some Lethean draught, erase the remembrances I speak of, I would drink it; for they are easily brought back, and are never welcome."

"After perusing," continues Sir James Simpson, "such a touching and terrible account of what surgical patients were sometimes called upon to suffer, before the introduction of modern anæsthetics, it is delightful to reflect that all these forms of human agony are essentially ended and abrogated. We now know also and acknowledge that these tortures, so long endured as dire necessities, were of no advantage, but the very reverse, to the patient himself. . . . While anæsthetics save the patient from the agonies produced by the cutting of his living flesh, they at the same time preserve his strength and enhance his chances of recovery. But they are not a boon merely to the patient: they are a blessing also to the surgeon himself, as they enable him to accomplish his knife-work far more calmly and deliberately."*

There is one use of anæsthesia in which, although it applies only to one sex, we must all rejoice. The pain, often amounting to agony, which, in obeying the first command, "increase and multiply," by a mysterious arrangement of Providence, woman alone endures, may, by the use of chloroform or similar agents be, with perfect safety to mother and child, rendered comparatively insignificant. And by the avoidance of the nervous exhaustion caused by long-continued suffering, life is often saved which, under different circumstances, would have been sacrificed.

Great, however, as have been the blessings conferred by general anæsthetics, their use has its drawbacks. A few persons have succumbed to their depressing effects on the vital energies. The discovery, therefore, of some means which, without producing general unconsciousness, would render the part to be operated upon insensible, had become a desideratum. The want has been supplied in more than one way. The local application, as proposed by Dr. Arnott, of ice or of freezing mixtures, by which the part was temporarily frozen, was a great advance; but the perfection of local insensibility seems to be attained by Dr. Richardson's beautiful invention of ether-spray.

* Anæsthetics do more for the surgeon even than this: they save him from possible physical suffering. The writer of this article, when many years since a dresser at a London hospital, had one of his fingers severely bitten by a poor little boy, who was undergoing a painful operation.

XUM

The same end—the prevention of suffering—has also been attained in another way, to which some allusion has already been made, *viz.* the simplification of the modes of dressing the wounds caused by surgical operations. The improvement in this respect has been gradual. The cumbrous dressings and often torturing applications of our remote forefathers, the boiling pitch into which the amputated limb was plunged, or the heated iron by which the surface of the recent wound was seared, had long been banished from use; but the dressings were still too complicated, and the mode of closing the larger blood-vessels by ligature inevitably prevented the early healing of the wound, by leaving between the two surfaces foreign bodies, the ligature threads and particles of dead and putrid matter, the extremities of the blood-vessels, detached by the pressure of the ligatures. The very recent discovery of acupressure—a discovery for which we are indebted to the illustrious discoverer of chloroform—has to a very great extent removed both these obstacles to the speedy healing of surgical wounds. By needles of suitable size and length passed either through the external skin over the vessels to be closed, and again brought out through the skin, or applied in other ways which need not here be described, pressure is made on the arteries; the lips of the wound are then brought together by metallic sutures, an immense recent improvement, and further closure is effected by a few strips of isinglass plaster; the limb is then placed in a suitable position, with due provision for its immobility, and, with the exception of the withdrawal of the needles after the lapse of a few hours, or at the most a day or two, and after a longer interval the removal of the wire-sutures, the treatment is complete. Nature does all the rest. There is, say those who have extensively tested this mode of dressing, no sloughing, no suppuration, no absorption of pus, and consequent surgical fever; there are no painful dressings repeated daily for, perhaps, weeks. To use the words of a speaker at the late annual meeting of the British Medical Association in Dublin, "If surgeons are strangely apathetic as to the desirability of attaining such results, patients are not equally so. I was lately told by a medical friend of the case of a gentleman who had a tumour, some time ago, removed in Edinburgh, and who, after being operated upon, was weeks in getting well. After returning home, he happened to get hold of a book on acupressure, by Dr. Pirrie, and after reading it, angrily argued with his ordinary attendant, my informant: Why was I tortured for six weeks to please old surgical prejudices, when I might have been cured in a day or two?"

The illustrations we have so far given of the recent improvements in the art of medicine have been drawn from one branch of it, that, *viz.* which deals with external diseases and injuries. But in the treatment of the ailments more especially coming under

the care of the physician, results equally great in the aggregate, although, perhaps, not individually so splendid, have been produced. The most valuable, perhaps, of these has been increased confidence in the efficacy of drugs. The remark was long since made, by whom first we know not, that the mind of every practitioner who thinks for himself, and is not content to be guided merely by routine, passes through three stages. In the first stage he has unbounded confidence in medicines. In the second, disappointed by the non-realization of the brilliant dreams of his youth, he doubts their efficacy altogether. In the third stage, that of mental maturity, he believes that, judiciously administered in accordance with the teachings of enlightened empiricism, they can do a great deal. The professional mind, as a whole, has within the last half-century gone through a similar series of changes. But a few years since it appeared to be sinking into a hopeless condition of scepticism as to the utility of strictly medicinal treatment. A brighter age has happily succeeded. A discriminating confidence in the powers of remedies of proved efficacy has taken the place both of doubt and of blind faith in all drugs; and here again the duty of relieving pain, and of avoiding unnecessary suffering, has been recognized. It has come almost to be a fundamental principle that in nearly all diseases, acute or chronic, of which pain is a prominent symptom, to relieve the pain is to cure the disease, and that therefore, wherever narcotics do no harm in other ways, they ought to be administered. Modes of giving them otherwise than by the mouth have in consequence been devised, and one of those is so ingenious and so elegant, if the expression is admissible, as to be worthy of description. By means of a little syringe, having a nozzle drawn out into a minute pointed tube, perforated like the fang of a rattlesnake a little way below its extremity, a few drops of concentrated solution of morphia are injected under the skin, so as to come directly into contact with the extremities of the nerves of the painful or inflamed part. To quote a portion of one of the many recent professional utterances now lying before us, "We see neuralgia of long standing cured by one injection of morphia; we see the same treatment visibly restoring to health congested vessels of the conjunctiva; reducing unnatural heat, not of the whole body, but of a suffering portion of it; lessening the swelling of an inflamed joint; arresting vomiting, depending on a lacerated brain, or upon peritonitis, or suppressed menstruation." *

The hypo-dermic administration of medicine has not been limited to morphia. Other vegetable alkaloids have been given in the same way. The most promising results thus obtained have been when

* Mr. T. P. Teale, jun., Opening Address at the Leeds School of Medicine. —*British Medical Journal*, Oct. 5.

two powerful remedies, which in their operation on the brain and nervous system are antagonistic to each other, such as morphia and atropia, the active principle of belladonna, are injected simultaneously. The headache and phantasms of atropia have been found to be controlled by morphia, as well as the partial deafness and the visual defects of the former alkaloid. Conversely the drowsiness and stupor caused by morphia disappear under the use of atropia. In other respects the two remedies thus administered have been found to be mutually antidotal.*

Who knows how many lives of persons poisoned by opium, and too far narcotized to be capable of swallowing, may be saved by the subcutaneous administration of atropia?

To these triumphs in the cause of humanity something must still be added. It must often occur to the earnest-minded practitioner that in the exercise of his calling he is treading in the steps of his Divine Master, whose chief work on earth was to heal the mental and bodily diseases of those who came to Him.

But the physician now, if it may be said without irreverence, goes beyond his Master, although he is only following out the natural developments of his Master's teaching.

To use the words of an eloquent and popular writer:—"No man who loves his kind can in these days be content with waiting as a servant upon human misery, when it is possible in so many cases to anticipate and avert it. Prevention is better than cure, and it is now clear to all that a large part of human suffering is preventable by improved social arrangements. . . . When the sick man has been visited, and everything done which skill and assiduity can do to cure him, modern charity will go on to consider the causes of his malady, what noxious influence besetting his life, what contempt of the laws of health in his diet or habits, may have caused it, and then to inquire whether others incur the same dangers, and may be warned in time. . . . Christ commanded his first followers to heal the sick and give alms, but He commands the Christians of this age, if we may use the expression, to investigate the causes of all physical evil, to master the science of health, to consider the question of education with a view to health, the question of labour with a view to health, the question of trade with a view to health, and, while all these investigations are made, with free expense of energy and time and means, to work out the re-arrangement of human life in accordance with the results they give."†

In justice to the faculty of medicine be it said, that some of its members were among the first to recognize these great truths.

* 'Biennial Retrospect of Medicine and Surgery for 1865-6.'—*New Sydenham Society*, p. 460.

† 'Ecce Homo,' 4th edition, pp. 196, 202.

Happily they do not now stand alone. The exertions of a small band of zealous men, continued through many weary years, have at length succeeded in placing Preventive Medicine in something like its proper position in the estimation of the profession and of the general public. It is now seen to be as much the duty of our rulers to care for the Public Health, as to make provision for the peace and the material prosperity of the community.

Within the last few years several Acts of Parliament bearing upon Public Health, each on the whole an improvement on its predecessor, have been passed, and the last of them, the 'Sanitary Act of 1866,' requires only, to make it almost perfect, that some of its enactments, now permissive, should be made compulsory.

In other countries also the subject is attracting attention. We have lately seen an assemblage of diplomatists met, not to divide conquered provinces or to obviate threatened war, but to prevent, if possible, another invasion of Europe by the pestilence which had already three times ravaged many of its cities and towns.

These are encouraging facts, but to make our condition perfectly satisfactory much has yet to be done. We want a Government Department of Public Health, presided over by a single responsible head. We want travelling inspectors, constantly at work, to anticipate local outbreaks of preventable disease, and not to be sent down only when such outbreaks have occurred. We want medical officers of health in every registration district, and we want a higher status and more power for the medical officers in the three great public services, the Army and Navy and that of the Poor Law. Recent events have shown the miserable consequences of the disregard of the advice of military and naval surgeons, and the country would have been spared the shame and the sorrow of the recent revelations of the condition of the workhouse infirmaries, metropolitan and provincial, had the medical officers been placed in a more independent position, and had the Poor Law Board trusted rather to their reports than to those of inspectors too often incapable or careless. Thanks to the non-official inspections organized by the proprietors of the 'Lancet,' and more recently by the British Medical Association, a better state of things has already been inaugurated in the metropolis, and improvements will, it is to be hoped, follow in the provinces.

Before concluding, we wish to direct the attention of our medical readers especially to one mode of preventing disease, to which some of them, it is to be feared, are not yet sufficiently awake. Too many of the buildings designed for the reception and treatment of poor persons suffering from various ailments or accidents, by their very construction, generate maladies far more dangerous than those they are designed to cure. We believe that there is not a public hospital in the kingdom, built before the Crimean War, which is

not unfit for its purpose—which does not kill many of those it ought to cure. Surgical fever, or Pyæmia, is the bane of general hospitals; puerperal fever, of obstetric institutions. Small are the chances, more especially at certain seasons of the year, of the man whose leg has been smashed by a railway accident or similar casualty, and who undergoes amputation in an old-fashioned hospital. Far better would it be for him to be treated in a hovel on a bleak hill-side, or under a tent. In like manner, the poor women who in their hour of sorrow have to depend on public charity, have far better chances if attended in their own comfortless homes, than in many a luxuriously furnished maternity hospital of the old construction. The conviction of these truths has recently led to the proposal to abolish hospitals altogether, and to substitute for them clusters of cottages which shall accommodate one, or at most two, patients in each room. Happily we need not make a change so sweeping and likely to be attended with so many inconveniences.

Hospitals built on the pavilion system, carried out in its integrity, may have as pure an atmosphere as a detached cottage, and the medical officers of the older hospitals, who do not with all possible urgency strive to impress upon those in authority the duty of rebuilding their hospitals on the improved plan, will assuredly incur a grave responsibility. The example has been set in the Herbert Hospital, in the new St. Thomas's, and in the new infirmaries at Leeds, and some other places, and it is to be hoped that it will be universally followed.

VII. FARADAY.

On the 25th day of August, 1867, a spirit passed away from amongst us, leaving a gap amidst the noble few, who have, by the powers of their intellectual industries, placed themselves in the position of being the rulers,—the instructors,—of mankind. All that remained of Faraday was laid in the earth at Highgate, on the 30th of the same month, without display, without parade, and the busy world, involved in the circles of its joys and cares, appeared to be little conscious of the extinction of a light, by the aid of which it had been advanced into some of the recesses of Nature, and gleaned a few of those truths which alone are capable of giving man power over matter.

With a strange inconsistency the world applauds with enthusiasm the doings of the warrior, the influences of whose labours are often the chaining of truth, the reinvigoration of vice, and the perpetuation of ignorance amongst men. The appreciation of his greatness is shown by recording in enduring bronze, above his ashes,

the deeds by which he has been distinguished, the triumphs which he has won. Whereas the man who has devoted all the powers of his mind with unwearying industry to seeking out "the knowledge of causes, and secret motions of things, and the enlarging of the bounds of human empire;"* the man who really advances the human race by dispelling ignorance, by dethroning superstition, by throwing light into dark places, and by training all in the right use of that intellect with which they have been gifted, and by the strength of which alone they can fulfil the first command of the Creator and subdue the earth—he passes away in silence, and is consigned to "the lap of earth," with the mournful tribute of the tears of a few; but with slight indications of sorrow from the many. "The storied urn or animated bust," however, which rises in honour of him who has trodden "the paths of glory" are but short lived in comparison with the monument which is reared for him who has linked his name with the discovery of some Eternal Truth.

Mr. Davies Gilbert, to whom we are indebted for the discovery of the Carver's Son, at Penzance, who "was said to be fond of making chemical experiments," who raised himself to the temporal rank of Sir Humphry Davy, Bart., and to the intellectual position of the leader of Science, once said, paraphrasing a remark made respecting Bergman and Scheele, "The greatest discovery Davy ever made was the discovery of Faraday." This, be it remembered, was not spoken by Davies Gilbert in depreciation of the master, but it was a forcible way of putting his high appreciation of the merits of the man.

In recording our sense of the loss which the world has sustained, we have no intention of writing a memoir of Michael Faraday, even in brief: That he was born on the 20th September in 1791, the son of a blacksmith at Newington, in Surrey, and that he died,—having achieved for himself a world-wide reputation,—in the Royal Palace of Hampton Court in 1867, at the age of seventy-six, is the sum of our notice of the ordinary life of Faraday. But we have something more to say respecting the higher life, the intellectual labours of this great man. Faraday's childhood was one of promise, and all the learning which a common day-school could give him was turned to early account. At thirteen he became the apprentice of a bookbinder, and the books of Science which he bound, he so far made his own as to be enabled by their guidance to construct electrical machines and to try chemical experiments. In 1812, through the attention of Mr. Dance, Michael Faraday was taken to hear some of Davy's lectures in the Royal Institution. "I took," Faraday writes to Dr. Paris, "notes, and afterwards wrote them out more fairly in a quarto volume. My desire to escape from trade, which I thought vicious and selfish, and to enter into the service of

* Bacon: 'New Atlantis.'

Science, which I imagined made its pursuers amiable and liberal, induced me at last to take the bold and simple step of writing to Sir H. Davy, expressing my wishes, and a hope that, if an opportunity came in his way, he would favour my views; at the same time I sent the notes I had taken at his lectures." Davy was kind and generous, he saw Faraday and procured for him the situation of assistant in the Laboratory of the Royal Institution, then just vacant; but, writes Faraday, "he smiled at my notion of the superior moral feelings of philosophic men, and said he would leave me to the experience of a few years to set me right on that matter."

It has been most unjustly stated that Davy soon grew jealous of his assistant, and that during a visit to Paris, in October, 1813—Faraday having been appointed assistant only in March of the same year—he was annoyed at the attention which the French chemists paid to the young man; and that in 1824 Davy showed much unwillingness to Faraday's being elected as a Fellow of the Royal Society. The first statement is so absurd that it carries its own refutation; of the second, it can only be said that Davy never exhibited any unwillingness to the election of Faraday to the honours belonging to F.R.S.; but we have reason to know that Davy was slightly annoyed that the certificate proposing Faraday for election should have originated with Richard Phillips, and that he should not have been consulted before that gentleman was allowed to take the matter in hand.

It is not possible to trace out here the progress of Faraday as an experimentalist, or as a discoverer. His early devotion to Chemical Science was richly rewarded. Passing over several smaller matters, we may mention the discovery of Benzole in 1825, to which "we virtually owe our supply of aniline with all its magnificent progeny of colours." Such is the judgment of Hofmann, who demands, "Who, then, discovered benzole?—England may well be proud of the answer, Michael Faraday." He was ever a searcher after Truth, regardless of any money value belonging to a discovery; but he, doubtless, felt "that the search after the True for its own sake leads on to the discovery of its natural corollaries, the Useful and the Beautiful. For these, indeed, lie folded up in Truth, to be in due time evolved therefrom; even as the great tree unfolds itself from the little seed."*

Other fine chemical investigations were carried out, and other discoveries made, by Faraday about the same time. In 1821 was published his paper on the condensation of the gases, in which he proclaimed them to be simply the vapours of volatile liquids.

The important position assumed by the Science of Electricity, at this period, naturally won the attention of Faraday. In the same year, the 'Quarterly Journal of Science' contains a paper

* Hofmann.

"On some new Electro-Magnetical Motions, and on the Theory of Magnetism," in which was announced the brilliant discovery of the rotation of a wire under electrical excitation round a magnetic pole. This paper is in every way remarkable; but it is especially so in being the precursor of a series of Memoirs which certainly stand as the finest exemplification of the value of inductive science which the world has received since it had birth from the mind of Bacon.

It is impossible to give even a sketch of the remarkable series of experiments which stand recorded in the "Experimental Researches in Electricity," or to record the chain of discoveries which, link being added to link, led us from the most simple phenomena of electricity up to the very threshold of what we may, without presumption, believe man is permitted to know of its connection with animal life.

Without these "Experimental Researches," we should not now be employing Electro-Metallurgy as a practical art. The Electric-Light,—especially as evolved from magnetic arrangements,—would never have been brought to that degree of certainty and steadiness, as well as brilliancy, which has recommended its adoption in the light-house economy of England and of France; and, beyond all, the electric current, with even the extraordinary mechanical powers of Wheatstone to promote its application to the purposes of telegraphy, would never have been brought under control; and neither the wires which now girdle the world, nor the cables which, lying hidden in the ocean, bind Europe and America together, would have had existence.

But none of these applications were made by the discoverer of most of the truths upon which they depend. The mind of Faraday was of that order which could not bend itself to the labour of making science a stepping-stone to commercial enterprise. The feelings shadowed out in his letter to Davy, which has been quoted, followed him to the end. If ever any man pursued Truth for its own exceeding great reward, with an entire abandonment of all selfish feeling, that man was Faraday. Not that he disregarded the value of science in its practical applications—he rejoiced to see those discoveries which appeared abstract brought to the test of usefulness—but he worked earnestly in the elucidation of the great mysteries of Nature, feeling certain that no truth could be born into the world which would not sooner or later become of value to mankind as an ameliorating or a refining agency.

Faraday was an Inductive Philosopher—nothing can be more beautifully precise than the method of his Experimental Researches. Step by step he advanced, making sure of each fact by testing it under all conditions, before he allowed it to support him in his attempt to reach another. Nothing can show this more satisfactorily than his paper on "Definite Electro-chemical Action," in which he arrives at his remarkable conclusions "On the absolute

quantity of Electricity associated with the particles or atoms of Matter." To this series of his Researches we are indebted for the enunciation of the startling truth that "The Chemical Action of a grain of water upon four grains of Zinc can evolve Electricity equal in quantity to that of a powerful thunderstorm," and that this enormous quantity of the Electrical Element is exactly that which is required to maintain the atoms of Oxygen and Hydrogen in the condition of a grain of water.

Faraday was not a Deductive Philosopher. As long as he solicited nature with his wands,—his experimental and ever beautifully contrived apparatus,—he was the Arch-evocator who proudly compelled an answer to his evocations, but, when he laid aside his wands and endeavoured *to think* out truths, he was still as noble as Prospero, but as powerless as the Duke of Milan, when he "his magic did abjure," breaking his staff to "bury it certain fathoms in the earth."

No other evidence of this is required than Faraday's "Speculations touching Electrical Conduction and the Nature of Matter,"* and his clever papers "On Magnetic Hypothesis,"† and "On some points of Magnetic Philosophy."‡ In these, and in other essays which might be named, Faraday displays his remarkable genius, in picking up the threads of an argument and weaving them together into a symmetrical cord, but when he casts that from his hand as a lasso to entangle a distant and flying truth, he shows that he is not practised in the art. His early education (and "the child is ever father of the man") unfitted him for large generalization. In this he stood on a lower pedestal than Davy, and why? The circumstances of the place of birth had much to do with this. Faraday was born and educated at Newington, and apprenticed in Soho. Davy was born on the beautiful heights of Ludgvan, looking down upon a bay, unrivalled in the world; and he was educated at Penzance, where nature has been lavish of her charms. Faraday learnt to love nature in the mechanical aspects which she assumes in the fuliginous metropolis,

> "But 'midst the crowd, the hum, the shock of men,"

Davy's boyish delight was

> "To sit on rocks, to muse o'er flood and fell,
> To slowly trace the forest's shady scene;"

and thus, in the day-spring of life,

> "to hold
> Converse with Nature's charms and view her stores unroll'd."

* 'Philosophical Magazine.' 1844, vol. xxiv.
† 'Experimental Researches,' vol. iii.
‡ 'Philosophical Magazine,' Feb., 1855.

This gave to one mind that Poetry, without which there can be no Deductive Philosophy, which was denied to the other.

Faraday's powers as a lecturer were surpassingly great. The secret of his power was earnestness, an intense desire to be the Minister of Truth, and a determination to make every one familiar with her mysteries, so far as he was permitted to be their interpreter. He spared no labour to ensure a correct understanding of each fact. He never supposed anything to be known. When the writer of these remarks was preparing to deliver his first lecture in the Theatre of the Royal Institution, "Do not," said Faraday to him, "suppose that your audience will know anything of the subject you are about to bring before them," and taking a stone from the table, "was I about to tell them that this stone when set free from my hand will fall to the ground, I should let it fall." This was a brief lesson, but one of incalculable value.

Faraday was great as an Experimental Philosopher, he was even greater in all the relations of life. He might have been proud of the position which he occupied as an investigator of Nature; but, to the end of his days he was all humility as a man. We may be allowed to apply to Michael Faraday those lines addressed by Dr. Johnson to the Electrician, Grey:—

"Long hast thou borne the burden of the day
Thy task is ended, rever'd Faraday!
No more shall Art thy dextrous hand require,
To break the sleep of elemental fire!
To rouse the power that actuates Nature's frame
The momentanous shock, the Electric flame.

"Now, hoary sage! pursue thy happy flight,
With swifter motion, haste to purer light,
Where Bacon waits with Newton and with Boyle,
To hail thy genius and applaud thy toil;
Where intuition breathes through time and space,
And mocks experiment's successive race;
Sees tardy science toil at Nature's laws,
And wonders how the effect obscures the cause.

"Yet not to deep research or happy guess,
Is show'd the life of hope, the death of peace;
Unbless'd the man whom philosophic rage
Shall tempt to lose the Christian in the sage:
Not Art, but Goodness, poured the sacred ray
That cheer'd the parting hours of FARADAY."

CHRONICLES OF SCIENCE.

1. AGRICULTURE.

The country has now for a month or two been free from the Cattle Plague; and we may hope, that if the requisite precautions be taken at the ports of debarkation for foreign cattle, we may remain free from it for the future. In Cheshire, Norfolk, and Berwickshire—three widely separated counties—cases have been reported, and districts have been declared by the local authority to be infected; but in every instance, a further investigation, by the Veterinary professors sent down by the Government, has shown that the disease has not been Rinderpest, but some malady which has generally arisen from maltreatment. The provision of a metropolitan market exclusively for imported cattle near the point of landing, which is now contemplated, with extensive lairage there for young and breeding stock imported to be fed in England, will, we hope, reduce the risk of any reintroduction of the infection to a minimum. Meanwhile, however, we may place on record, that the history of the last great attack of the disease, which occurred at Lodge Farm, near Barking, in August last, proves that strict isolation and the abundant use of hot lime on roads and of carbolic acid in and about the cowsheds, enable us to insulate infected places, so that the mischief shall not spread. On a farm where 237 cows had been fed in six or seven separate sheds, two of these sheds, containing 111 cows, were kept free of it in this way, notwithstanding that the disease was raging on all sides of them.

The close of the Paris Exhibition enables many of our agricultural readers to look back upon the unequalled illustration it has afforded of the implements and farm economy of many nations. There was certainly something in the dairy and general homesteads, of which specimens were given from Holland, to instruct the English agricultural spectator; but it was to the British section of this department chiefly that not only we, but the agricultural machine-makers of all other countries, looked for guidance. Now that the display is over, exhibitors are discussing both the relative and the actual value of the awards of medals and of merit which have been made by the examining juries. One thing seems certain: they bear no relation whatever to either the relative or the actual professional status of the several exhibiting countries. We are accustomed here to consider that the productiveness and enterprise of our

agriculture is in direct proportion to the quantity of live stock maintained upon a given area of land. Guided by the application of such a test as this, the relative standing of English and French agriculture may be read with greater accuracy in the agricultural exhibition of them out of doors, than in the awards of an international jury examining the agricultural contents of the Exhibition building and its annexes. There are more cattle and sheep seen on the return journey of the English tourist within eight miles of the landing at Newhaven than are visible all the way from Paris to Dieppe.

Among the topics which receive attention in the current number of the 'English Agricultural Society's Journal,' is the agricultural value of town sewage. It appears that nitrogen equal to 200 ozs. of ammonia passes annually from every average individual of a general population, and this being mixed with the usual annual water-supply to our towns of 40, 60, or 80 tons per head, gives only $9\frac{3}{4}$, $6\frac{1}{2}$, or $4\frac{3}{4}$ grains to every gallon of the resultant sewage. If the average be taken at 7 grains to every gallon, which is equal to one in every 10,000 parts of the drainage water, then that is worth about as much as half-a-ton of Peruvian guano for every 1,000 tons, or between $1\frac{1}{2}d.$ and $1\frac{3}{4}d.$ per ton. Nothing like this valuation has, however, ever yet been realized in agricultural experience. The large quantity of water with which the guano in sewage is diluted, spoils its fitness for our more valuable crops. It has hitherto indeed been applied almost exclusively to grass, which is not worth more than 6*s.* or 8*s.* a ton in country districts, rising, however, to 15*s.* or even 20*s.* a ton near towns, where it can be used in cow feeding. The calculation from experience near Edinburgh and at Rugby does not result in one-half the estimated return indicated by the chemistry of the subject. During the past year, however, on Lodge Farm, near Barking, a better result has been obtained from its use in growing Italian rye-grass on thin and gravelly soil. From 300,000 tons of North London sewage passed over 55 acres of Italian rye-grass, 2,400 tons of grass have been obtained. And as much of this land had been sown down only this spring, and a good deal of what was sown last year had been much injured by last January's frosts, all of it ought not in fairness to be taken into the account. Off $13\frac{1}{4}$ acres, the extent which was in good bearing order, 800 tons of grass was cut between April and November this year; and, as a good deal of the sewage had been wasted (in the carriers cut through gravel) before it could reach the plant, it is believed that one ton of grass has been produced over and above the natural and unassisted growth of the land for every 100 tons of sewage that was applied. If further experience shall justify this conclusion, then we shall at length have realized in agriculture something like the chemist's valuation of this manure; and a profit will be available for towns from their drainage waters, which recent legislation

very properly requires them to keep out of the rivers. It is also reported from Lodge Farm that the sewage has been successfully and profitably used in the growth of mangold wurzel, cabbages, Lucerne, potatoes, and celery; and that, where applied in dry weather, it has largely increased the yield of wheat. In all these cases, however, the experiments were on a small scale, and require confirmation. The area in grass, on the other hand, is quite enough to enable a trustworthy inference to be drawn.

It is in some degree connected with this subject (for the large addition to our supplies of succulent grass which is certain to be the first result of sewage utilization, will be somewhat difficult to turn to account), that the question of artificial haymaking and harvesting has occupied a good deal of attention during the past season. Mr. Gibbs, of Gillwell Park, Sewardstone, has patented an apparatus by which air heated in a furnace (and the ordinary agricultural locomotive engine may be used not only for the heat but the power required) is driven by a fan through sheaves of corn, which, wetted purposely for the experiment, were dried at the rate of 250 an hour. And this speed would, no doubt, be much greater if only the last portions of natural moisture had to be driven off, which hinder the completion of harvest work in a difficult season. Even, however, if the reported speed of four sheaves per minute should not be exceeded, that would be equal to the clearance of an ordinary crop at the rate of four or five acres a day; and this would often be of great service to the farmer in a wet harvest.

As regards the grass and other green crops of the farmer, it is an improvement of them, as the food of cattle, to get rid of a large proportion of the water which they naturally contain. And this is especially the case when they are used as winter food. It is somewhat interesting, therefore, to find that an attempt to produce a dry, or nearly dry cake from pulped, dried, and pressed mangold-wurzel roots, has been made, and that it has been found extremely nutritive in an experiment reported by Mr. Hugh Smith, of Great Hadham, Herts. Five sheep put up on May 26, to feed on oilcake and pasture, made 262 lbs. of increased live weight during twenty weeks, having consumed $7\frac{3}{4}$ cwt. of oilcake; and other five sheep fed on similar pasture, along with mangold cake, prepared from 3 tons 3 cwt. of raw mangold root, made 266 lbs., almost exactly the same increase, in the same time. The oilcake cost 4*l.* 9*s.*, and if the 3 tons 3 cwt. of mangold wurzel can be credited with having done as much as that value of oilcake did, certainly the roots were doubled in efficiency and value to the farmer by being dried. It can hardly be contended that this is so; but we may safely gather from the experiment that if a certain advantage is obtained in the warm summer months by removing a large proportion of the cold water which is given to our fattening stock in mangold wurzel and

other roots, a much greater advantage would undoubtedly be obtained in the winter season when so large a bulk of cold and watery food as is often given must not only waste but injure the digestive powers of the animal.

A recently published report of Messrs. Lawes and Gilbert affords a good illustration of the fact that living things have to obey the laws of their nature, and cannot be manipulated by treatment according to the arbitrary will of their cultivator. The experience of many years at Rothamstead has taught that special manurings have hardly any appreciable effect on the composition of the ash of wheat, which maintains its uniformity, whatever variation may have been artificially presented in the mineral food with which the crop has been fed. This fact tallies perfectly with the whole course of agricultural experience in teaching that the farmer cannot with impunity set himself to be the master of his circumstances. If he be wise he will only endeavour to be their intelligent servant, trying to turn them to account, but avoiding the costly and wasteful process of opposing them. A living thing must be preserved in health if it is to yield abundant produce, and with that view it must be treated according to its nature; and so, whether it be plant or animal that is cultivated, the maximum of produce will be obtained not necessarily by presenting it with abundance of the ingredients or elements of which that produce consists, but by taking care simply to provide the conditions of healthy growth, leaving the produce to develop as it may.

Dr. Voelcker's researches into the composition of town milk have lately been published in the columns of the 'British Medical Journal,' which has startled its readers with proof of the scandalous adulterations generally practised by the milk-dealers. Of only one out of ten samples analyzed from as many different shops, could it be said that the milk was pure; though sold at 4*d.* and 5*d.* a quart it was really in general worth only from 1*d.* up to 3*d.* for that quantity. In one case examination proved that artificial colouring had been added, that one-fourth of the cream had been removed, and one-sixth of water added! In another, the "new country milk" was skim-milk, with one-third water added! In a third, one-fourth of the cream had been taken, and 33 per cent. of water added! Genuine country-milk contains 4 per cent. of fatty matter, 3 per cent. of casein, and nearly 5 per cent. of milk-sugar; but of these three ingredients the figures were 3, 2¾, 4—1·6, 2·8, and 4·1—1·62, 2·68, and 4·09 respectively—in some of the examples investigated by Dr. Voelcker. And in the second of these instances the price charged was 5*d.* a quart, and the profit per annum must have been 200*l.* a year on every ten gallons sold per diem. It is plain that all classes dealing with the shops from which these samples were obtained are being victimized, and the

robbery falls heavily upon the poor. If the results thus obtained represent the average truth, then one milk dealer out of every ten is an honest man! We hear with pleasure that a company is being started in Switzerland for the preservation of milk in the form of cakes, and we are told on good authority that such cakes, dissolved in England, produce beautiful rich milk.

During the recent autumnal meetings of local agricultural societies, the subject of agricultural education, including that of the future tenant-farmer as well as that of the future agricultural labourer, has occupied attention. Members of both Houses of Parliament, and landlords as well as tenant-farmers, have concurred in urging the importance of instructing boys in the principles of the art by which they are to be maintained in after-life; and whether it were Mr. Read, M.P., addressing agricultural labourers at North Walsham, or Colonel Kingscote, M.P., addressing a farmer's club in Gloucestershire, or Earl Spencer and Earl Leicester speaking at an agricultural meeting in Norfolk, the advantages of technical education were not only admitted by them but insisted on. It is in accordance with this opinion that the educational efforts of the English agricultural body are for the future to be confined to the promotion of the strictly professional branches of an agricultural education.

A preliminary statement issued by the Board of Trade, anticipating a fuller report which has yet to appear, announces that there were in England and Wales in corn crops of all kinds this year, 7,941,578 acres, against 7,921,244 acres returned in 1866; and in Scotland, 1,367,012 acres, against 1,366,540 acres last year. The land under wheat is returned for England and Wales at 3,255,917 acres, against 3,275,293 acres in 1866; and for Scotland, as 115,118 acres, against 110,101. The number of cattle in England and Wales is 4,017,799, an increase of about 150,000 within the year; and in Scotland, 979,170, an increase of 40,000. Sheep are returned for England and Wales at 22,097,286, an increase of nearly 6,000,000 over the previous return; but this is owing to the return for 1866 having been required before lambing time, for the purpose of the Cattle Plague inquiry. There were 6,893,600 sheep in Scotland at the date of the inquiry this year.

Among the noteworthy agricultural incidents of the past quarter we may record here the prices reached at a public sale of shorthorn cattle, chiefly yearlings, imported from the United States. Animals of the pure "Duchess" family of shorthorns had been purchased in England ten or fifteen years ago by American breeders, and now their surplus stock are being returned to us, and eight sold by Mr. Strafford at Windsor the other day, averaged 408*l.* 3*s.* 9*d.* a-piece; a young heifer reaching the extraordinary price of 700 guineas!

2. ARCHÆOLOGY AND ETHNOLOGY.

The most important event of the past quarter in Pre-historic Archæology is no doubt the opening of the Blackmore Museum, at Salisbury. The value of this museum lies in the fact of its being a *special* collection of antiquities—characterizing a particular period—with illustrative modern examples. Mr. William Blackmore stated, at its opening, that the nucleus of this museum is the renowned "Squier and Davis" American collection, which was purchased by him in the year 1864. To this has been added a valuable collection of stone implements from the various caves and drift-deposits of England and the Continent, with a most interesting illustrative series of the modern stone implements at present used by various savage races. Mr. Blackmore has munificently given this remarkable collection to his native town; he has also built a museum for its reception, and has provided for its future maintenance. Its management has been undertaken from year to year by the committee of the Salisbury and South Wilts Museum, with the consent of the Blackmore Museum Trustees, in whom the property is vested. The trustees are three in number, namely, Mr. Blackmore, Dr. Blackmore (brother of the founder, and well known for his researches on the drift deposits and the flint implements contained in them), and Mr. E. T. Stephens: the last two being also the honorary curators. Henceforth those who wish to learn the evidence which is known respecting the antiquity of man and collateral questions connected with it will find this museum a most valuable, and indeed indispensable, aid. It was opened in the beginning of September with great *éclat*, the proceedings, which occupied two days, including the reading of papers, a conversazione, and the formal presentation at its opening by Mr. Blackmore.

No account of the proceedings of the "Congrès Paléoethnologique" seems to have been published; but Mr. Boyd Dawkins has printed in the 'Intellectual Observer' for October a paper read by him, entitled "Man and the Pleistocene Mammals of Great Britain." It consists chiefly of an historical account of the various discoveries of flint implements in Great Britain, and especially of his own findings at Wookey Hole. He makes, however, one statement, which it may be useful to reproduce, as showing that these indications of man's coexistence with extinct animals are not so wonderfully abundant as we seem, almost unconsciously, to have been brought to believe:—"Out of the thirty caverns explored in Great Britain, the contents of which I have classified, *four only have yielded human remains;* while out of forty river-deposits containing mammalia, only three have furnished any trace of man. Had man been very abundant in those days, we might certainly have hoped to have

found his implements more widely spread, and especially as they were fashioned out of a material that is almost indestructible."

In the same and the succeeding number of the 'Intellectual Observer,' Mr. Jewitt gives the first two portions of a most interesting description of the Grave-mounds of Derbyshire and their contents. He divides them into three divisions, according to their age, namely, the Celtic, the Romano-British, and the Anglo-Saxon, by far the greatest number belonging to the first-named period, and the smallest number to the second. In these two instalments he describes the barrows of the Celtic period, the various modes of interment, and the objects of flint, bone, stone, and pottery found in the graves. The barrows contain interments by inhumation and cremation. In the former case, "the body is mostly found in a contracted position on its side," but occasionally it is found lying at full length. In the latter case, "the remains of the burnt bones, &c., have been collected together, and placed either in a small heap or in a cinerary urn." Referring to the immense amount of heat which must have been used in burning the bodies, Mr. Jewitt asks, "Is it too much to suppose that the discovery of lead may be traced to the funeral pyre of our early forefathers?" The cinerary urns are either inverted over a flat stone, or are upright and the mouth covered by one. When the bones are placed in a heap they are often surrounded by stones. Frequently the interments have been made in cists, and a barrow may contain one or more of these chambers; but sometimes the barrows are formed almost wholly of earth. The flint implements are varied in form, and frequently of exquisite workmanship; the stone implements consist of adzes (celts) and hammer heads, as well as whetstones and other miscellaneous objects. Besides these, are beads, rings, studs, necklaces, &c., of jet; celts, daggers, awls, pins, &c., of bronze; and a variety of articles in bone, including modelling tools, personal ornaments, lance and spear-heads, whistles (?), hammers, &c. Not a single article of gold has been found in any Celtic barrow opened in Derbyshire, but a few have been turned up by the plough. The pottery consists of cinerary urns, food vessels, drinking cups, and the so-called incense cups. Mr. Jewitt considers that this pottery has been baked by the action of fire, and with regard to the "Incense Cups," he thinks it probable that they were used to receive the ashes of infants sacrificed at the graves of adults—their mothers, for instance.

The report of the Nottingham Meeting of the British Association, which was published as usual twelve months after date, contains the "Second Report of the Committee for Exploring Kent's Cavern, in Devonshire." The facts made known up to the present time may be briefly summed up as follows:—The present floor of the cave was strewn with immense boulders, which had fallen from the roof, between and beneath which was a deposit of black mould or

mud, from three to twelve inches thick; beneath this was a stalagmitic floor, graduating downwards into a firm stony breccia, and beneath this again a thick accumulation of "cave-earth," of unknown depth, including a large number of angular fragments of limestone, but without any indication of stratification. In the black mould have been found objects of human workmanship in slate, stone, bone, and bronze; a few flint flakes, two fragments of plates of smelted copper, and numerous pieces of pottery. With them were associated bones of various existing animals, such as pig, deer, sheep, badger, fox, numerous rodents, &c.; pieces of charred wood, and shells of several kinds of snails.

Few remains have been discovered in the stalagmitic floor; they consist of terrestrial and marine shells of existing species, and bones of various recent and extinct animals. In the cave-earth a large number of bones of extinct animals have been found, including *Elephas primigenius, Rhinoceros tichorhinus, Felis spelæa, Ursus spelæus*, and *Hyæna spelæa;* with these were discovered nearly one hundred flint implements, excluding doubtful specimens and mere chips. This cave-earth has been worked to the depth of four feet, and the Committee have kept a record of what was discovered in each level of one foot deep. The flint implements and bones were most numerous in the first foot below the stalagmite, and the implements of most elaborate workmanship were found in the lowest levels, of three and four feet deep; those from the four-foot level being "the most elaborately finished tools of the cavern series."

Speaking generally as to the relative abundance of implements in the levels, the Committee state that "up to this time each level has been rather less productive than those above it." The explorations of the Committee have been scrupulously made in those portions of the cavern which have not been disturbed by earlier investigators, whose statements they have been able to confirm in every particular, except the asserted occurrence of *Machairodus* and *Hippopotamus*, and human bones, which they have not yet met with. We look forward to reading the conclusions at which the Committee have arrived in a future report.

In a pamphlet, entitled 'A Descriptive List of Flint Implements found at St. Mary Bourne, with Illustrations of the Principal Types,' Mr. Joseph Stephens records (at p. 23) his discovery of a spot which had evidently been the scene of flint working during a long period, occupying a small space in an open field, known as Breach-field, on a hill near the village of St. Mary Bourne. In a few visits he succeeded in finding "more than 100 cores, about 200 arrow-head and spear-head flakes, a score of axes, besides a quantity of so-named scrapers, sling-stones, awls, drills, wedges, hammers, crushers, and a heap of pot-boilers." He states that all the implements are of the "surface-type," and mostly of very rude workman-

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ship; that they possess a "strong family likeness," as if they were the work of a particular tribe or family; and that they are diffused through the soil, fresh specimens appearing after heavy rains.

An important work, entitled "L'uomo fossile dell' Italia Centrale," by Signor Igino Cocchi, has been published in the third volume of the 'Memoirs of the Italian Society of Natural Science.' The author describes the Post-pliocene and Recent deposits of Central Italy, and the Pliocene strata of the Val d'Arno and Val di Chiana, with the fossil mammals, mollusks, and plants, obtained from the latter. The Recent deposits he divides into Modern, consisting of various alluvial formations, and an Ancient alluvium, yielding obsidian implements. The Post-pliocene deposits are divided into Upper and Lower, the former comprising the Loess as its upper member, without any fossils or human remains, but probably belonging to the Reindeer-period; and as its lower member, various deposits known as the Diluvium of Central Italy, &c., containing remains of *Bos primigenius* and its variety *B. trochoceros*, &c., together with stone knives. The Lower Post-pliocene strata are subdivided into an upper portion, consisting of ferruginous conglomerate, &c., without human remains, but otherwise containing similar fossils to the underlying deposit. The lower portion consists of lacustrine clays of great thickness, with layers of peat towards its superior margin; it contains bones of *Elephas primigenius, Cervus euryceros, Bison priscus*, and a species (probably new) of *Equus;* it has also yielded stone implements, and a human cranium, the latter from the plain of the Aretino. It is satisfactory to learn that at last a fossil human cranium has been discovered associated with remains of extinct animals in a true stratified deposit, and whether this deposit be termed Lower Post-pliocene, or anything else, there seems little room for doubt that the cranium was imbedded contemporaneously with the remains of *Elephas primigenius*, &c., and that Man lived in Italy contemporaneously with those animals.

M. Pierre Béron has devoted a portion of the third volume of his 'Physique céleste' to a discussion, entitled "La Terre et l'Homme avant et après le Déluge." So many wonderfully far-fetched ideas are crowded into 150 pages, that they would render the ancient cosmogonies commonplace by comparison. To Anthropologists this book will be a curious study, and will show them how very wild the imagination of a clever man can run; beyond this we cannot see that it has any scientific value.

Mr. Rose's extensive collection of implements and weapons illustrative of the Stone Age in Denmark has been exhibited in the museum of the Anthropological Society during the past month. It is perhaps more remarkable for the number of specimens it contains than for the variety of types illustrated, although in the latter respect also it has a certain value.

3. ASTRONOMY.

(Including the Proceedings of the Royal Astronomical Society.)

We regret to have to record the death of three distinguished astronomers—Sir James South, Lord Wrottesley, and Lord Rosse.

Sir James South was one of the founders of the Royal Astronomical Society, and for some time its President. We are indebted to him for a valuable catalogue of double stars, which he compiled in conjunction with Sir John Herschel. Of late, his great age and increasing infirmity have prevented him from taking any important part in furthering the progress of Astronomy; but he has continued to take great interest in the science.

Lord Wrottesley was also one of the founders of the Royal Astronomical Society. He received the Society's Gold Medal for his 'Catalogue of Stars.' He was President of the Royal Society from 1854 to 1857.

William Parsons, Earl of Rosse, was born in 1800. He took first-class mathematical honours at Oxford in 1822. In 1843 he presided over the meeting of the British Association. From 1849 to 1854 he was President of the Royal Society. He is chiefly celebrated for the ingenuity and mechanical ability displayed in the construction of the great Parsonstown reflecting telescope. In 1831, Lord Rosse had erected a telescope, one yard in diameter, and nine yards in focal length, smaller, but probably more efficient than Sir W. Herschel's great reflector. Not only was the construction of this instrument superintended by Lord Rosse, but he had worked upon the speculum with his own hands. Encouraged by the success of this instrument, he commenced the construction of a more gigantic telescope. The new instrument was fifty-two feet in focal length, and seven feet in diameter, with a six-feet speculum. It was first applied to the survey of the heavens in 1845. We could not spare one-tenth part of the space which would be required even to summarize the work of the great reflector. It must therefore suffice for us to say, with the late Professor Nichol, that "it has converted what was twilight into daylight and has penetrated into regions of space formerly enveloped in utter darkness." It has also brought within our ken a new and wider circle of twilight, and has enlarged correspondingly our estimate of the unknown—of the boundary of darkness lying beyond the penumbral band that encloses our "circle of light."

We were not favoured, as had been hoped and expected, with a display of the November shooting-stars. We hear of countless meteors having been seen in Paris, but the account is not confirmed by trustworthy authorities. In England there was certainly no *display*, though several shooting-stars were seen. We do not hear

that a shower was seen in Canada or the United States, where it was supposed there was a more favourable prospect of a noteworthy display being observed. It is just possible that we may still hear of the shower having been seen in the eastern parts of Asia. But we must remember that the presence of the full moon was sufficient in any case to have prevented a large number of shooting-stars from being seen. For it was noticeable in the display of November 14, 1866, that most of the shooting-stars were not brighter than stars of the third magnitude, and as fixed stars of this magnitude can scarcely be seen on a hazy moonlit night, such as that of November 13–14, it seems probable that all the smaller shooting-stars would escape notice altogether. It is to be considered also that Jupiter has now been for several months in a position which brings his attraction to bear very efficiently on that part of the shooting-star system traversed by the earth in November. And as his influence acts now to sway the system *outwards*, it is far from being unlikely that the earth may have passed inside the ring of meteors, instead of through it as she did last year.

The opinion we have seen expressed, that the absence of a great display ought to throw doubts on the general conclusions of astronomers respecting the November shooting-star system, is wholly erroneous. Even if it were absolutely certain that there had been no shower of falling-stars, all that could be learned from this would be what astronomers have long since inferred, that the band of small bodies forming the system is not continuous.

A careful examination of the observations made upon Jupiter on August 21, when he was (apparently) without satellites, reveals some noteworthy results. The best observers differ as to the relative dimensions of the shadows of the third and fourth satellites. But it is remarkable that those who used refractors considered that the shadow of the fourth looked larger than that of the third satellite, or, where no comparison is directly instituted between the shadows, that the shadow of the fourth satellite seemed noticeably larger than the satellite itself. On the other hand, the best observers with reflectors, considered that the shadow of the third satellite was larger than that of the fourth. As it is readily demonstrable that the real shadow of the fourth was much smaller than that of the third, and the penumbra much larger, it seems to result that reflectors are less efficient than refractors in exhibiting faint shadows and half-lights. Even refractors, however, did not exhibit the distinction of tint between the penumbra and the true shadow.

The dimness of the fourth satellite was a very noteworthy feature. It looked as dark, says Mr. Dawes, as its shadow, but smaller. One observer suggested even that the fourth satellite suffered eclipse by the third, during a part of the transit, but this certainly did not happen. At the time mentioned by this observer,

the fourth satellite hid a small part of the third satellite's shadow on the disc,—but, of course, an eclipse of one satellite by another would be indicated by the coalescing of the two shadows, which did not and could not happen on August 21st last, since the apparent paths of the shadows across the disc were separated by a considerable interval.

Lastly, a strange dark space divided by a narrow channel of light occupied one-half of the third satellite's disc, and this space resembled one seen in 1860 by the same observer—Mr. Dawes—but was on the opposite side of the disc. This observation seems conclusively to overthrow Sir W. Herschel's theory, that the satellites turn always the same face towards the planet, as our moon towards the earth.

A strange amount of doubt still clings to the supposed discovery of volcanic action within the lunar crater Linné. At a late meeting of the Astronomical Society Captain Noble expressed the opinion that the changes supposed to have taken place in Linné are due entirely to variations in the state of the earth's atmosphere, and of the moon's illumination and libration. Mr. Buckingham, on the contrary, judged from his observations that real changes had taken place. On August 6, he detected a convexity in the white cloud, which after it entered the terminator appeared as an egg-shaped convex disc. On October 19, he saw parts of the whole ring and fragments of a broken ring with his 20-inch refractor. On November 5, he could still see the summit of the small crater, which seemed larger than before. He considers that the crater is considerably larger than at the beginning of the year, and nearer the centre of the cloudy spot. Mr. De la Rue controverted the opinion expressed by Mr. Proctor, that photographs of the Moon afford evidence of change (the photographs referred to being those by Messrs. De la Rue and Buckingham).

At the same meeting the discussion of the circumstances attending the eclipse of the Moon on September 13, elicited from Mr. Buckingham the interesting statement that a portion of the unobscured part of the Moon was absent from the photographs. Mr. De la Rue, who has before observed this peculiarity, expressed its nature by saying that *more of the Moon is eclipsed chemically than optically.*

It is perhaps hardly necessary that we should make even a passing reference to the so-called Newton and Pascal controversy. Never before, we imagine, has so barefaced an attempt been made to impose upon the scientific world. The chief care of the author of this contemptible affair appears to have been devoted to the concentration of every possible absurdity and blunder within the range allotted to the correspondence he has been at the pains to invent. French scientific men, generally, have acted in this matter in a

manner very creditable to themselves. It is painful to have to note as an exception one eminent mathematician, who having assumed a false position, seems to be ashamed to withdraw from it.

An annular eclipse of the sun will take place on February 23rd. It will be invisible at Greenwich, but the northern line of simple contact will pass very close to England, so that in the northern parts of France the eclipse will be visible as a partial one.

Venus will be well situated for observation during the ensuing months, as an evening star. She will attain her greatest easterly elongation on May 6th.

We have to announce the discovery of two more Asteroids, both detected by Professor Watson, of Ann Arbor (U. S.)—one on the 24th of August, the other on the 6th of September, 1867.

The twenty-five inch object-glass, which has been for some time in the hands of Mr. Cooke, the eminent optician, is at length completed. This is the largest refractor that has ever been constructed, and we may look for important discoveries through its application to the observation of celestial objects. For it has been shown satisfactorily that the object-glass is optically excellent. On November 5th, 1867, the telescope was directed to the star γ Andromedæ, and the small companion was seen distinctly divided, with the spurious discs of the three stars of this triple system perfectly round. "To those who know what a telescope is," says the President of the Astronomical Society, "and how the difficulties of making it are enormously increased with extension of aperture, this statement is enough." He added that in his opinion there were several opticians in London who could make a glass of the same dimensions and optical accuracy, and that therefore it was quite unnecessary to seek out of England—as is frequently done—for any optical instrument whatever.

Mr. Dawes has at length completed the list of double-star observations, which has been one of the results of his long and most valuable labours with the telescope.

Proceedings of the Royal Astronomical Society.

Dr. Edmund Weise supplies an important and valuable paper on the total eclipse of August 17th, 1868. He has computed the position of the central line of the eclipse and of the limits of the totality, by Hansen's formulæ. He finds that the shadow touches the earth near Gondar, in Abyssinia, crosses the Straits of Bab-el-Mandeb, including Perim, Mokha, and Aden; leaves Arabia by the Cape Râs-Furtak, and enters the peninsula of India between Goa and Rajahpoor. We have already described the path of the shadow across India. The maximum duration of totality occurs in the

Gulf of Siam, when it reaches on the central line no less than 6′ 50″, the altitude of the sun being 87½°. On its further progress, the shadow runs through Borneo, Celebes, the Islands Bouru, Amboyna, Ceram, and the Arrou Archipelago; covers completely the southern part of New Guinea, and moves then towards the New Hebrides, where the totality begins at sunset.

What renders this eclipse so important an object of attention to astronomers, is the fact that the totality lasts almost as long as is possible under any circumstances. For at the commencement the Moon will have just passed a perigee of uncommon proximity, and she reaches during the eclipse the ascending node of her orbit. Thus the eclipsed sun rises nearly to the zenith of those countries where the eclipse takes place at noon; and therefore the augmentation of the moon's diameter (due to her altitude) is a maximum, and the rate at which the shadow sweeps over the surface of the earth is a minimum. The result of the coincidence of all these favourable circumstances will be an eclipse without rival in the records of past eclipses. There are to be found only two which may be compared in size with that of August 17, 1868, and none in which the totality lasts so long. The first is the eclipse of Thales (May 28, 585 B.C.), said to have been the first predicted, and to have concluded a fierce engagment between the Medes and Lydians. The second was visible on June 17, 1435, in Scotland, and the time of its occurrence was long remembered by the people of that country as "the black hour."

But besides its enormous size, the eclipse deserves special attention in another respect. In researches on the nature of the red protuberances and other phenomena visible during total solar eclipses, it would certainly be of the highest importance to learn something about the nature of changes to which these appearances may be subject. On a single place upon the shadow's path, the time of visibility is too short to permit of the hope of perceiving processes of physical change in these objects; but it is far from being improbable that observations, obtained at several places along the line of totality, might afford the information we seek on this point. In the present instance the shadow touches a series of accessible regions, as we have seen. It is also very probable that favourable weather will prevail at the time of observation.

It would certainly be well that efforts should speedily be made to take advantage of so favourable an occasion for extending our knowledge of solar physics. Centuries will pass before we have such another opportunity.

Turning to Major Tennant's remarks on the subject of the same eclipse, we find that much has been done in the way of preparation. The Council of the Astronomical Society has decided that there should be provided for photography a silvered-glass reflector,

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equatorially mounted and driven by clockwork. The Astronomer Royal also offered to lend Major Tennant two telescopes from the Royal Observatory.

As respects Photography, the conditions as to time rendered it unadvisable to attempt to use a speculum of more than 9¼ inches diameter. The picture will be taken at the side of the tube, the telescope being a Newtonian one. Provision has been made to obtain a field of more than one degree in diameter, so that, if possible, some traces of the structure of the corona may be obtained in the photograph. The important difference between the position of an equatorial used in such low latitudes as the central parts of India and one used in our latitudes, have rendered new designs necessary for almost every part of the mounting. Hence many unavoidable delays have taken place with respect to this part of the arrangements.

Measures have also been taken to apply tests for the polarization of light from the coloured protuberances and the corona, the following three methods being applicable:—

1st. The extinction of the polarized portion of the light by means of a Nicol's prism, reducing the intensity of the image to a minimum.

2nd. Savart's test, where parallel fringes are formed by the interference of the polarized rays, the central one being either dark or light, as its plane is in or perpendicular to the plane of polarization.

3rd. By a double-image prism and analyzing plate, giving images of complementary colours with polarized light.

The first two of these tests can be instantaneously interchanged, and there is no difficulty in using all these tests successively in two minutes.

For spectrum observations, the Astronomer Royal has lent Major Tennant one of the old collimators of the Transit-Circle at Greenwich Observatory. An equatorial mounting is being constructed for this, to follow any object steadily, but without clockwork. The spectroscope will allow of the spectrum being compared with a scale of equal parts, by means of which its peculiarities can be referred to the lines of the solar spectrum.

All the estimates for the expenses of the proposed operations have been duly sanctioned.

Mr. Proctor gives the elements of his new determination of the Rotation-period of the planet Mars. A comparison of pictures taken by Mr. Browning in February of the present year with Hooke's observations in March, 1666—giving a period of nearly two hundred and one years—have enabled Mr. Proctor slightly to correct his former estimate—in obtaining which one or two small errors had crept in. He now gives for Mars' sidereal day the

period 24h. 37m. 23·73s., in place of the period 24h. 37m. 27·745s., first obtained.

Mr. Cayley gives an expression for the angular distance of two planets, the sun being the centre of reference. Those who are interested in questions of this sort, will be able to judge of the nature of the paper from the statement that,—υ and υ' being the longitudes of the two planets in their orbits, θ and θ' the longitudes of their nodes, and φ and φ' their inclinations, then Mr. Cayley finds an expression for the required angular distance, in terms of cos $(\upsilon-\upsilon')$, sin $(\upsilon-\upsilon')$, cos $(\upsilon+\upsilon')$, and sin $(\upsilon+\upsilon')$, the coefficients involving the quantities θ, θ', φ, and φ'.

Mr. Gill supplies a note on the Trapezium of Orion. He was able, with a good achromatic only $3\frac{3}{4}$ inches in aperture, to detect the exceedingly minute star 7 of the Trapezium. He also suspected the presence of a more minute star similar in R. A. to 9, and having the same declination as δ. It may be noticed in passing, that 6 of the Trapezium has been seen, with an achromatic only $3\frac{1}{4}$ inches in aperture, by Cooke.

It appears that, after all, the variable T Coronæ, whose sudden appearance so startled the astronomical world in May, 1866, may have been visible before evening set in, in England, on May 12th. For Mr. Walter, surgeon of H.M.'s 4th Regiment, in North India, saw the star shining at least as brightly as Alphecca at eight o'clock on the evening of that day, an hour corresponding to about half-past two in the afternoon at Greenwich. It seems possible therefore that Mr. Stone was mistaken in rejecting the evidence given by Mr. Barker, of Canada; evidence, however, which we are bound to say bore a very questionable appearance.

Mr. Weston supplies a paper on the appearance of Jupiter's satellites and their shadows when transiting Jupiter's disc, on the evening of August 21st, 1867. He records the apparition of false satellites adjacent to the true ones, and distinct from the shadows. Such appearances, which have been observed by others, must, we think, be referred to optical delusion, since Mr. Dawes and other observers of the first class have failed to notice them. Mr. Weston, using a 9-inch Newtonian reflector, noticed that the shadow of the third satellite seemed larger than that of the fourth, an appearance which—as we have already said—seems to have been presented in almost every case, to observers who used reflecting telescopes.

Mr. Leeson Prince, in a paper on the same phenomenon, calls attention to the fact that the remarkable darkness sometimes observed in the fourth satellite when transiting Jupiter's disc, was observed and recorded nearly a century-and-a-half ago by Mr. J. Pound. This well-known astronomer took the satellite for its shadow, so dark was the former; and was surprised—soon after seeing the dark spot which he thus mistook—to see another and

darker shadow pass on to the planet's disc. The first, when in the middle of the disc, was almost as dark as the second when near the edge of the limb, but somewhat less in size. "From which it is very plain," he adds, "that the first of these spots was the fourth satellite itself, and the second its shadow. We have seen the first and second satellites appearing, not as dark spots, but as bright ones (somewhat differing from the light of Jupiter), for some little time after they have entered the disc; but as they approach the middle we lose sight of them; and we have frequently observed that the same satellites appeared brighter at some times than at others; and that when one of them hath shined with its utmost splendour, the light of another hath been considerably diminished. From whence it is very probable, at least, not only that the satellites revolve upon their proper axis, but also that some parts of their surfaces do very faintly—if at all—reflect the solar rays to us," an interesting passage, considering the date of the observation.

4. BOTANY AND VEGETABLE PHYSIOLOGY.

America.—*Vibrios in Hot-water.* Dr. Jeffries Wyman has been making some experiments on the appearance in hot-water of living organisms, which have some interest as touching upon spontaneous generation and some problems of Cryptogamic Botany. He concludes—

1. In thermal waters, plants belonging to the lower kinds of algæ live in water, the temperature of which, in some instances, rises as high as 208° F.

2. Solutions of organic matter boiled for twenty-five minutes, and exposed only to air which had passed through iron tubes heated to redness, became the seat of infusorial life.

3. Similar solutions contained in flasks hermetically sealed, and then immersed in boiling water for periods varying from a few minutes to four hours, also became the seat of infusorial life. The infusoria were chiefly Vibrios, Bacteriums, and Monads.

4. No ciliated infusoria, unless Monads are such, appeared in the experiments referred to in the above conclusions.

5. No infusoria of any kind appeared if the boiling was prolonged beyond a period of five hours.

6. Infusoria having the faculty of locomotion, lost this when exposed in water to a temperature of from 120° to 134° F.

7. If Vibrios, Bacteriums, and Monads are added to a clear and limpid organic solution, this becomes turbid from their multiplication in from one to two days. If, however, they have been previ-

ously boiled, the solution does not become turbid until from one to two days later.

The experiments of Dr. Child, of Oxford, and of other recent observers, are referred to by Dr. Wyman.

England.—*A new Arctic Conifer.* In the 'Journal of Botany,' Mr. Andrew Murray describes the most northerly tree that has been met with on the north-west coast of America. It was found in the voyage of H.M.S. 'Herald,' forming forests on the banks of the rivers Noatak and Buckland, on the American side of Behring's Straits. This latitude is nearly seven degrees farther north than the limits of the woods on the eastern side of the American continent. This tree was described originally by Dr. Seeman as a variety of *Abies alba*, but Mr. Murray thinks that certain differences in the bract of the scale warrant a separation, and calls the new species *Abies arctica*. The desolate country where this tree is found is thus described by Dr. Seeman:—"There is nothing to relieve the monotony of the steppes. A few stunted Coniferous and Willow trees afford little variety, and even these, on passing the boundary of the frigid zone, are either transformed into dwarf bushes or disappear altogether. About Norton Sound groves of White Spruce trees and *Salix speciosa* are frequent; northwards they become less abundant, till in latitude 66° 44′ north, on the banks of the Noatak, *Pinus alba* disappears."

An Edible Fungus from Tahiti.—Mr. Brander, of Tahiti, gives an account of a fungus which is largely exported to Sydney. It is found principally in the Society and Leeward Islands, on decayed trees. The Tahitians call it "Teria iore" (*i.e.* "rat's ear"), from a fanciful resemblance of shape. The fungus first began to be collected in 1863, and fetches in China, where it is much esteemed and made into soups, from eighteen to twenty cents a pound.

Excellent articles (chiefly technical) occur in the same number of the 'Journal of Botany,' on the Plants cultivated or naturalized in the valley of Caracas, and on the staple products of Jamaica.

Weeds and their Characteristics.—Dr. Henry Trimen has made some very sensible remarks on the use of the term "weed," in reply to some observations on the same point by Dr. Seeman. Dr. Seeman says that a weed signifies a naturalized herb, which has a soft and membranaceous look, grows fast, propagates its kind with great rapidity, and spreads to the prejudice of endemic or cultivated plants, in places in some way or other disturbed by the agency of man. Dr. Trimen urges that the popular idea of a weed is any plant, irrespective of origin or appearance, occurring in cultivated ground, in addition to, and therefore more or less interfering with and injurious to the crop intended to be grown. This is the idea of a weed in the mind of horticulturists and farmers, and as it is sufficiently definite Dr. Trimen objects to the restricted sense

given by Dr. Seeman. The essential thing about a weed is, that it is *out* of place. A sunflower in a field of turnips is as much a weed as *Brassica napus* in a flower-garden, but reverse their situations, and the term is inapplicable to either. So when waste land, such as a heath, is enclosed and brought under cultivation, the species composing its original flora become weeds in the new fields. With regard to the term "weedy" Dr. Trimen thinks that it means something more than "soft and membranaceous," many weeds being quite the reverse of this. From the situation of many "weeds" in rich and manured soil, and amongst other and taller plants, they acquire a luxuriant and rapid growth and a straggling habit. It is these characters which are especially implied in the term according to the old proverb, "Ill weeds grow apace." Etymologically no doubt, as Dr. Trimen and others before him have remarked, "weed" is connected with the Anglo-Saxon "weód," which means clothing or covering either of earth or man. Hence our expression "widow's weeds."

Fungi and Gregarines in the Hair.—A somewhat acrimonious correspondence on the chignon parasite has been going on in the 'Journal of Botany' between Dr. Beigel and Dr. Tilbury Fox. After the occurrence of small organic growths on prepared hair had attracted public attention, Dr. Beigel appears to have obtained specimens of the parasite, and sent them to the distinguished German algologists, Rabenhorst and Küchenmeister. These gentlemen named the little plant—which is the simplest possible aggregation of highly refracting minute cells—*Pleurococcus Beigelii*—and Dr. Beigel related what they had done in the 'Journal of Botany.' Dr. Tilbury Fox, who is known as an observer and writer of great ability on skin diseases, published his opinion that the specific or even generic distinction of the parasite could not be maintained, and that like other fungoid growths, it was a function of the nidus rather than of the spore from which it sprang. The consequence has been a reiteration of the distinctiveness of his *Pleurococcus* by Dr. Beigel. The term Gregarine was unfortunately made use of by Lindemann, originally, in speaking of this growth; it is really, as admitted both by Drs. Fox and Beigel, most inappropriate—*Gregarinæ* being indubitably animals, and of endo-parasitic habit.

Mr. John Bishop has described another case of Fungoid disease affecting the hair, to the Edinburgh Botanical Society. This occurred in the hair of the beard which, under its influence, broke off short, curling up and assuming a dried-up appearance as though singed. It appeared to be almost impossible to extirpate the fungus. Examination with the microscope showed a cellular fungus-growth within the hair—causing the destruction of the part by disrupting it from within. Sporules and mycelium branching among the broken fibres of the hair are occasionally to be seen.

Gases in Plants.—Messrs. Faivre and Dupré have experimented on this subject and submitted their results to the Edinburgh Botanical Society. They examined more especially the mulberry and the vine, and have arrived at the following conclusions:—1. The presence of gases in the interior of the root, stem, and branches in the mulberry and vine is a normal and constant fact. 2. The composition of these gases changes with the epochs of vegetation. 3. During the period of inactivity, carbonic acid is in very small proportion, and is scarcely appreciable. Oxygen is present to the same extent as in atmospheric air. During the phase of activity the contrary takes place, and the changes are more marked in proportion as the vegetation is more energetic; with the progress of vegetation, the proportion of oxygen diminishes. 4. In the roots during the epoch of vegetation, the quantity of oxygen is not so great, while that of carbonic acid is greater than in the branches examined under the same circumstances. 5. In the branches, as well as in the roots, there is an inverse relation between the oxygen and the carbonic acid; by adding to the normal oxygen that disengaged under the form of carbonic acid, we obtain a number which is scarcely above the proportion of oxygen in the air. 6. In the mulberry and vine, injections do not penetrate the pith or the bark, whether in the branches or roots. The ligneous layers are alone permeable to mercury. The more the formation of the vessels increases, the easier and more complete are the injections. The injections are fuller in the roots than in the branches; they are also more in the branches than in the young herbaceous shoots. In the old stems of the mulberry, the central layers cease to be permeable. 7. Microscopic examination proves that the injection specially penetrates the pitted and reticulated vessels, and also the spiral vessels in the young herbaceous shoots. 8. The pitted vessels show distinctly the mercury in the areolæ, as if in so many little pouches formed by thin portions of the wall; the same observations have been made in regard to the reticulated vessels.

France.—*Absorption by the Roots of Plants.*—It is still a vexed question as to how far the roots, of plants absorb certain elements of their food, such as carbonic acid. M. Corenwinder has applied himself to the solution of this problem, believing that very rash statements as to the functions of the roots have been lately made by M. Boussingault and others. He states it as his conviction that plants have not the power of absorbing carbonic acid from the soil by their roots, or that at least the quantity which permeates the tissues from this source represents but a very small proportion of the total amount of carbon their tissues contain. Boussingault stated that in the air contained in an ordinary soil he found no less than ten per cent. of carbonic acid. M. Corenwinder asks what is the source of this large quantity of gas, and replies that it arises from the mass of decom-

posing organic matter, leaves, &c., which in the processes of agriculture and by the influence of the earth-worm, &c., become embedded in the soil. M. Corenwinder, however, does not say what becomes of this carbonic acid. Liebig and other chemists answer the question better in showing that the carbonic acid is taken up by water which percolates through the soil, and that it is then used in eroding rocks and dissolving up otherwise insoluble mineral matters.

Aëriferous Vesicles of the Utricularieæ.—S. B. Schnetzler publishes an account in the 'Annals of Natural History,' of these curious appendages to the leaves. The genus *Utricularia* consists of aquatic plants which are found in the stagnant waters of ditches, marshes, &c. The leaves are submerged and divided into fine lacinæ furnished with the remarkable utricles. De Candolle states that when the plant is young these vesicles are filled with a mucilage which is heavier than water, and the plant held down by this ballast remains at the bottom. Towards the period of flowering, the leaves secrete a gas which makes its way into the utricles and drives out the mucilage by raising an operculum or lid with which the utricles are furnished. The plant thus becomes furnished with a multitude of air-bladders, and rises slowly and at last floats at the surface. After flowering in the air, the mucilage is again secreted and the plant sinks again to ripen its seeds below water. M. Schnetzler has carefully investigated the morphology and history of these organs, and concludes that they play the part at once of organs of respiration and of a hydrostatic apparatus. The organs do not appear at a given moment and for a particular purpose, but as a natural consequence of the anatomical structure of the plant and the action of the surrounding medium. After some philosophical generalizations the author observes, "The totality of the forms in which life manifests itself upon the earth, during a given epoch, appears to us like a magnificent mosaic, of which the different pieces brought together mutually determine their nature."

The Fall of Leaves.—Dr. Maxwell Masters has recently discussed this subject in a very seasonable article in the 'Popular Science Review.' It appears from the researches of M. Trécul (published in the 'Comptes Rendus') and others, that in many plants a phenomenon occurs just before the fall of the leaf, which is not unlike the process which accompanies the shedding of horns in animals. It consists in the obstruction of the proper vessels at the base of the petiole or leaf-stalk. This obstruction is caused by the multiplication of cells, which first occurs in the parietes of the vessels. The cells increase and multiply, till at last the vessels are completely choked up in the neighbourhood of the insertion of the leaf, and thus a differentiated plane is formed, across which the leaf-stalk breaks, and the leaf accordingly falls.

Movements of the Sensitive Plant.—M. Bert and M. de Blon-

deau have published accounts of some investigations into this highly interesting matter in the 'Comptes Rendus.' It is to be regretted that more critical examinations of the phenomena of movement in the higher plants have not been made. M. Bert shows that the natural and regular movement of the leaves, which takes place in the Sensitive plant, is produced by a different cause from that to which the sudden contraction is due when the plant is touched by the fingers. M. Blondeau's observations are exceedingly curious, and are well worth further examination. He submitted three plants to the influence of an electric current from a Ruhmkorff's coil. The first he acted on for five minutes; when left to itself, the plant seemed prostrated, but after a quarter-of-an-hour, the leaves opened, and it seemed to recover itself. The second specimen was acted on for ten minutes. The specimen was prostrate for an hour, after which it slowly recovered. The third specimen was galvanized for twenty-five minutes, but it never recovered, and in twenty-four hours it had the appearance of a plant struck by lightning. A fourth plant was etherized and then exposed to the current. Strange to say, the latter had not any effect, the leaves remained straight and open; thus proving, says M. Blondeau, that the mode of the contraction of the leaves of the Sensitive plant is in some way allied to the muscular contraction of animals.

5. CHEMISTRY.

(Including the Proceedings of the Chemical Society.)

Among the papers calling for special mention this quarter are those by Dr. A. W. Hofmann, "On the Production of Formic Aldehyde." The method by which the author has succeeded in forming this hitherto unknown body was shown at a meeting of the Chemical Society, and will be described in our Report of the Proceedings. Other papers of great scientific value have been communicated by the same author to the Royal Society, "On the Homologues of Prussic Acid."* These also were briefly referred to at the meeting of the Chemical Society.

Dr. E. Schunck has also contributed to the Royal Society a valuable series of papers "On the Chemistry of Urine." These, as well as the paper by Dr. Hofmann, do not admit of abridgment, and we must refer our readers interested in the subjects to the Proceedings of the Royal Society.†

The past quarter has not been marked by any specially interesting discovery, and but few facts call for notice. M. E. Duclaux‡

* 'Proceedings of the Royal Society,' vol. xvi., p. 144. † Vol. xvi., p. 73.
‡ 'Comptes Rendus,' t. lxv., p. 1099.

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has noticed the formation of what he believes to be a Hydrate of Sulphide of Carbon. If a little water is placed on a glass plate, and a watch-glass full of the bisulphide is set in the midst and then blown upon, the water soon congeals, and the watch-glass is filled with snow-white flakes of the supposed hydrate. A lighted coal brought to the snowy mass sets fire to the bisulphide, which burns away, leaving the water with which it had united. The author has several times determined the amount of the water, and finds it to be constant, and just the quantity required by the formula 2 C S_2, H_1 O.

The formation of this substance, we may add, is easily shown in another way. If a stream of the bisulphide is made to trickle down a piece of loose twine, the twine quickly becomes covered with a thick crust resembling hoar-frost. The substance, whatever it may be, rapidly evaporates, leaving the twine perfectly dry.

A new process for the production of sulphuric acid has been patented in France, and probably in England, by MM. Tardani and De Susini. Its great recommendation is that it dispenses with the large leaden chambers necessary to the English process. We must refer our readers to the source indicated below* for full particulars, and need only say that the Sulphur or Pyrites is burned in compressed air, and the sulphurous acid is first washed to free it from arsenic and other contaminations, and is then brought in contact with the nitric vapours in a small leaden chamber of peculiar construction. The reactions are precisely the same as in the old mode: the apparatus, however, it is said, occupies forty times less space, and an acid is obtained free from the ordinary impurities.

A new process for the manufacture of Soda has also been patented in France by M. Kessler. As in Leblanc's process, the inventor starts with common salt. This is intimately mixed with sesquioxide of chromium, either alone or with peroxide of manganese, and then roasted in a current of steam. The result is the evolution of hydrochloric acid, and the formation of chromate of soda. When the evolution of hydrochloric acid has ceased, the charge is drawn from the furnace, mixed with a proportion of charcoal or coal, and then reburnt. In this way the chromate of soda is converted into carbonate with the reproduction of sesquioxide of chromium. The soda is separated by lixiviation, and the sesquioxide is reserved for a future operation.

Two other technical processes deserve a short notice. One is for the extraction of indigo from rags dyed with that substance. The rags are first saturated with a weak solution of caustic soda, then placed in a boiler with a double bottom, and exposed for some hours to steam at 45lbs. pressure. The indigo in the rags is

* 'Bulletin de la Société Chimique de Paris,' Oct., 1867, p. 295.

reduced, and may be washed out. It may afterwards be precipitated from the soda solution, and recovered in a state equal to the best commercial sort.

Another inventor proposes to shorten the time of dyeing Turkey-red, by a previous oxidation of the oil used. This M. Bernard effects by heating the oil to 95° C. with a solution of chlorate of potash, and adding very gradually oxalic acid. The mixture is afterwards boiled for some hours. The oxidized oil, it is said, may be employed alone or in the form of an emulsion.

In connection with technical chemistry, we may mention the publication of a valuable paper "On the Cumberland Hæmatite Ores," by Dr. E. J. Tosh.*

A very delicate test for hyposulphite of soda has been published by Mr. Carey Lea.† A very dilute, but rather strongly acid, solution of sesquichloride of Ruthenium is first rendered alkaline by ammonia, and then boiled with the suspected solution. If hyposulphite be present, the liquid assumes a red colour, which varies in intensity according to the amount of hyposulphite. A solution containing one four-thousandth gives a clear rose-red; one containing a twelve-thousandth, a well-marked pink colour. A strong solution gives a colour so intense as to appear almost black. Such a test will be highly appreciated by photographers; but, unfortunately, ruthenium is yet a very rare metal.

Proceedings of the Chemical Society.

The first meeting of the present season was held on November 7. After the adoption of an address of condolence to Mrs. Faraday, Mr. W. H. Perkin read a paper "On the Action of Acetic Anhydride upon the Hydrides of Salicyl, Ethly-Salicyl, &c." A paper by Messrs. Chapman and Smith, "On Nitrous and Nitric Ethers," was next read. It gave an account of the methods adopted by the authors for preparing the nitrates and nitrites of methyl, ethyl, and amyl, and described the reactions and decompositions which these bodies undergo when treated in a digestion apparatus with metals, acids, and other re-agents. The most interesting part of the communications was the description of an easy mode of preparing nitrate of amyl in large quantities. Three measures of a mixture of one part of nitric and two sulphuric acid are placed in a beaker set in a freezing mixture, and to these is added very slowly one measure of amylic alcohol. The addition is best made with the aid of a dropping funnel, the stem of which, reaching nearly to the bottom of the mixture of acids, serves as a stirrer. The nitrate of amyl is

* 'Chemical News,' Oct. 18–25, 1867.
† 'Silliman's Journal,' Sept. 1867; and 'Chemical News,' Oct. 25.

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produced without apparent action, and forms an oily layer on the surface of the acids. This is separated, washed with warm water, and rectified over chloride of calcium. The nitrate of amyl thus obtained is a colourless liquid, which boils at 147°–148° C., and at 7° or 8° C. has the same density as water. The inhalation of its vapour produces severe headache and other distressing symptoms.

Mr. Robert Warington then gave a short account of a long series of experiments, undertaken to determine the part taken by Oxide of Iron and Alumina in the Absorptive Action of Soils. The results may be summed up in a few words. Ferric oxide and alumina were found to withdraw nearly all the phosphoric acid from a carbonic aqueous solution of tricalcic phosphate. Hence the author believes that all the phosphoric acid applied to land in the shape of manure must ultimately become converted into phosphates of these bases; and, if sufficient iron is present, by preference into phosphate of iron. The absorptive action of the soil is thus seen to be dependent upon chemical affinity, and not upon physical attraction. As regards potassium and corresponding ammonium salts, it was found that the absorption was much greater in the cases of the phosphates, sulphates, and carbonates than with the chlorides and nitrates.

A discussion followed, in which Professor Way and Drs. Voelcker and Gilbert joined. The accuracy of Mr. Warington's results was not contested; but it seemed to be a general opinion that laboratory experiments of the kind described threw but little light on what happens in soils as they exist. Dr. Voelcker remarked that there was a remarkable tendency in nature for the soil to take care of itself; and if there should happen to be a deficiency of any one ingredient, it was quickly remedied by prior selection from a mixture of materials presented in the shape of manure. Dr. Gilbert agreed in believing that soils have almost an instinct to guide them as to what they should do.

The next communication was "An Analysis of the Water of the Holy Well, a Medicinal Spring at Humphrey Head, North Lancashire," by Mr. T. E. Thorpe. The water in question contains 508·5 grains of salts in a gallon, of which 331·75 grains is chloride of sodium, 88·49 grains calcium sulphate, 9·17 potassium sulphate, 24·39 grains sodium sulphate, and 43·48 grains magnesium chloride. The other ingredients need not be quoted.

An abstract of a paper by Dr. Wanklyn and Mr. A. Gamgee was next read. It was "On the Action of Permanganate of Potash on Urea, Ammonia, and Acetamide in strongly Alkaline Solutions." From the results obtained by the authors, it would seem that when artificial urea is heated in a pressure tube with a liberal amount of potash and permanganate, little or no oxidation takes place, and

nearly all the nitrogen is liberated in the form of gas. Ammonia under the same circumstances is completely changed to nitrate, and acetamide to nitrate or nitrite.

The last paper of the evening was also by Professor Wanklyn, and entitled "A Verification of Wanklyn, Chapman, and Smith's Water Analysis on a Series of Artificial Waters." A short account of the method of analysis pursued by these gentlemen will be found at page 532 of our last volume. The verification consisted in submitting pure water containing known amounts of albumen and urea to the treatment there described. In the case of albumen, mere traces of ammonia were obtained on the distillation with carbonate of soda, and only an amount corresponding to two-thirds of the nitrogen in the final distillation with caustic potash and permanganate. In the case of pure urea, little or no ammonia was procured on distillation with carbonate of soda, and the addition of alkaline permanganate did not induce the evolution of more than one-fourth the nitrogen in the form of ammonia. The author stated, however, that when urea is present with albumenoid matter, as in a natural water, the surrounding impurities start the reaction, and much of the ammonia (·37 out of ·46) can be obtained by long boiling with carbonate of soda.

At the meeting held on November 21st, Mr. E. T. Chapman made a verbal communication "On the Relation between the Results of Water Analysis and the Sanitary Value of Water." He said that a drinking water should contain no ammonia. Lime-salts he did not consider injurious; and water with nitrates in solution, but otherwise pure, he believed to be harmless. But when these ingredients were found in a water together, such water favoured the development of the lower forms of animal and vegetable life, and if kept in a cistern quickly acquired purgative properties. He had verified the latter statement by experiments on pigeons, and confirmed the results by experiments on the human system. He argued the necessity of observing the relations between the several ingredients in a water before pronouncing an opinion upon its sanitary value. He also recommended the extended use of Clark's softening process as a means of removing the most objectionable forms of organic matter in waters containing carbonate of lime; fully six-sevenths of the nitrogenous matter would be carried down with the precipitated carbonate of lime.

In the course of the discussion Mr. Dugald Campbell stated that water containing much nitrate and carbonate of lime was astringent rather than purgative; and Dr. Stevenson said he had examined water of which cholera patients had partaken, and found no organic matter.

Mr. Spiller mentioned that water softened by Dr. Clark's process did not permit the growth of vegetable organisms; and

Mr. Abel explained that this resulted from the entire absence of free carbonic acid.

Dr. Gladstone afterwards read a paper "On the Pyrophosphoric Amides."

At the meeting of December 5th, Mr. W. H. Perkin read a paper "On the Artificial Production of Coumarine," which was a detailed account of the researches briefly referred to at page 400 of our last volume. It was there stated that by the action of acetic anhydride on the hydride of sodium salicyl, the author had obtained a product completely identical with the natural coumarine extracted from the Tonquin bean. A most remarkable fact established by the extended researches of the author is, that by acting on the hydride of sodium salicyl with homologous anhydrides, such as butyric and valeric, other coumarines are obtained, which differ in composition exactly as the anhydrides, but agree in possessing in a greater or less degree the same odour, and behave, chemically, precisely the same as the natural coumarine. For the theoretical considerations we must refer our readers to the chemical journals.

Professor Church then made a preliminary communication on a Singular Colouring Matter obtained from some Feathers of a Bird of the Touraco family. This bird has crimson feathers in its wings, and it has been observed by ornithologists that rain washes the red colour out. This statement has been confirmed by the experiments of Mr. Church, which show that the colouring matter of the barbioles is really soluble in water, and particularly in water rendered slightly alkaline. An acid precipitates the colouring matter from the alkaline solution, and when separated it is found to be insoluble in alcohol and ether, and to resist the action of acids, short of completely destructive agents. On incinerating some of this colouring matter, Mr. Church made the still more extraordinary discovery that it contains a large proportion of copper. The absorption spectrum of the coloured solution differs but little from that of arterial blood. Mr. Church is continuing his investigations, and will give a further account of the substance at a future meeting.

A short paper, by Mr. J. Williams, on the Preparation of Artificial Urea, was then read. The author finds that cyanate of lead digested at a gentle heat with sulphate of ammonia is the most convenient means to employ. The urea or cyanate of ammonia is of course easily separated from the sulphate of lead.

Dr. A. W. Hofmann, whose appearance was welcomed with acclamations, then showed some Lecture Experiments to the meeting. The first illustrated the formation of methylic aldehyde.* This body has only been recently obtained. Former attempts to procure it from methylic alcohol have only resulted in complete

* See 'Chemical News,' Dec. 6, 1867, p. 285.

oxidation, and the production of formic and acetic acids. Dr. Hofmann showed, however, that by suspending a heated platinum spiral over warmed methylic alcohol and sending a current of air through the bottle, a limited oxidation of the vapour of the wood-spirit took place with the production of a body, the chemical behaviour of which left little doubt of its being true methylic aldehyde.

The next experiment illustrated the fact discovered by Cloez, that ammonia is transformed into prussic acid by the action of chloroform. The speaker showed that when chloroform is heated with alcoholic ammonia and caustic potash, chloride and cyanide of potassium are produced. It was also shown that all the primary monamines lend themselves to a similar reaction. The experiment was made with aniline, by means of which a body isomeric with benzonitrile is produced. It possesses an intensely disagreeable odour, which is common, it seems, to all bodies of its class.*

It would not be right to conclude the Proceedings of the Chemical Society for the past year without noticing the decease of Mr. R. Warington, F.R.S., F.C.S. He was one of the founders, and we believe it may be said with truth, the projector of the Chemical Society; and in the early days of the Society one of its most active members. Mr. Warington was well known as one of the most able practical chemists of the day. He died on November 12th, 1867, aged sixty.

6. ENGINEERING—CIVIL AND MECHANICAL.

The depression in all matters of private enterprise, to which we have on former occasions referred, still continues, and the Engineering profession will for many a long year remember the financial crisis of 1866-67. The price of all railway stocks continues to be quoted at a very considerable discount, but we think we see at last a slight glimmer on the horizon, the forerunner of more prosperous days. New railway companies in this country would scarcely meet with a shadow of support, and, consequently, the Bills before Parliament include but very few relating to such works. Two Metropolitan Extensions in London and a revival of the attempt to construct tramways, to be worked by animal power, through the principal thoroughfares north and south of the Thames, constitute, we believe, the most important part of that class of Bill. But although few new works of any importance have actually been commenced during the past quarter, several have been successfully completed, others are still in active progress, and many new projects have been determined on.

* 'Proceedings of the Royal Society,' vol. xvi., p. 144.

Amongst the most important events connected with railway construction we may mention that the last connecting link of the extensive system of high-level lines at Battersea, which has been in course of construction since 1864, to improve the access to the Victoria Station, London, was opened for traffic in October last. The works on the Metropolitan Extension Railway are making good progress. The East London Railway from Liverpool Street, including the junction on the south side of the Thames, will be seven and a half miles long, and is to cost 1,866,000*l.*

In Scotland, the Denburn Junction Railway, connecting the Caledonian line with the Great North of Scotland system at Aberdeen, has been opened for public traffic. This line is only a mile and a half in length, but by its means there is now an unbroken communication between the extreme north and south of the kingdom.

In October last the Mont Cenis Tunnel was advanced 131·85 metres, or upwards of 140 yards; and up to the 31st of that month 7,664 metres had been excavated, leaving 4,555 metres to be done to complete the work. The progress during the first ten months of the present year was 1,329 metres against 1,094 metres excavated during the whole of 1866. If the rate attained during October can be kept up, this tunnel would be completed in 1870.

The Italian Government has been pushing forward the construction of a line to unite Marseilles, Genoa, and Leghorn, *viâ* the littoral of the Mediterranean, and it was expected that a section, from Genoa to Chiavari, would be opened for traffic in the course of last November. The works of the Foggia line and the port of Brindisi have been recently inspected by the Italian Minister of Public Works; a considerable portion of the Foggia line, it is said, might be opened in December, but obstacles are feared.

The Baden Government has recently brought out a loan of 12,000,000 thalers, or nearly 2,000,000*l.* for railway purposes.

Great activity continues to be displayed in connection with the development of railways in Russia. Three important sections have been opened of late, *viz.* from Odessa to Tiraspol, from Warsaw to Tiraspol, and from Balta to Obriopol. The concession has been granted of a line from Poti to Tiflis, while surveys have been commenced for another line from Rostow, on the Don, to the Black Sea. And a line is to be constructed, at the cost of the State, from Koursk to Karkhow and the Sea of Azoff.

An extension of privileges has recently been granted by the Government of New Granada to the New York Panama Railroad Company. This company, it is said, will now extend the road two or three miles out into the Bay of Panama, so that the largest ships and steamers may load and discharge alongside the track.

There has been a good deal of talk of late about public works

in Turkey. The concession of a railway from Belgrade to Constantinople has been under consideration, as well as the construction of roads in Roumelia and Anatolia. A Franco-Belgian Company is said to be assured of a contract for docks at Constantinople, and the concession of the Roumelian Railways has been given to M. Van der Elss, of Brussels, who is to construct 450 kilometres of it before issuing any shares as bonds.

In India the past quarter has been conspicuous rather for the destruction than the construction of railway works. The great viaduct on the Bhore Ghaut suddenly collapsed, owing to imperfect construction, and many other bridges on the Great Indian Peninsula, and the Bombay, Baroda, and Central Indian Railways have been destroyed by the unusually high floods of the past season. Through communication between Calcutta and Bombay, *viâ* Jubbulpore and Nagpore, has been so far completed that it can now be effected in 116 hours. The only break of railway is between Jubbulpore and Nagpore, which, however, may be travelled by dâk gharry in 36 hours. It was expected that the north-west line of the Madras Railway would be opened as far as Gooty, some time last month. The works in connection with the construction of a tunnel under the River Indus, at Attock, have been ordered to be continued; but it has not yet been determined to continue the railway communication from Lahore to Peshawur. The Ceylon Railway was opened for goods traffic on 16th September last.

In Telegraphy we note the successful laying of the new cable between Placentia, Newfoundland, and North Sydney, Cape Breton; thus completing a new route from Nova Scotia to the Atlantic Cables, by which the Newfoundland land-lines are avoided. The Florida and Cuba Cable is at last at work, and it is now proposed to carry a line from the northern frontier of Florida to the port of Cherrara, situated at some leagues to the west of Havannah; various branch-lines are also contemplated. Mr. W. T. Henley, of North Woolwich, has successfully laid the Submarine Telegraph Company's cable from the South Foreland to La Paune, a small fishing-village in Belgium, close to the French frontier. The cable is a very heavy one, containing four conducting wires. All the principal police stations, and the principal station of the Fire Brigade in Watling Street, London, have at last been connected with the Chief Office in Whitehall by means of the telegraph.

The new Waterworks at Port Glasgow were opened with some ceremony on 15th October last. They consist of a large reservoir near the farm-stead of Leperstone, and a large filter and tank at the farm at Parkhill. The works are capable of supplying 12,000 people with 30 gallons of water a head per day. The waterworks for the town of Jedburgh are now in an advanced state; the reservoir at Blackburn is completed with the exception of the

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roofing, and the pipe track is finished. The tunnel through the Old Red Sandstone seam above Allar's Mill was completed early in November, and the distributing reservoir at the top of Castlegate is being proceeded with. The only drawback now is the Castle Hill tunnel, which has all along been a source of great anxiety to the contractors.

A company is to be shortly started for giving an improved water supply to Lisbon. It is proposed to bring to Lisbon the waters of the river Alviella by a canal 65 miles long. By this means it is calculated that a supply of 75 gallons a head per day will be assured to the population, which at presents amounts to 220,000 souls.

It is stated that contracts have already been let for the materials for the new bridge over the Niagara river. Its dimensions will be as follows:—height of towers 105 feet, width of span 1,250 feet, height above the water 175 feet, width of roadway 10 feet. A lattice-girder bridge has recently been erected across the Whitadder, about four miles from Berwick, the wooden one having been condemned; the estimated cost was upwards of 3,530*l*. A new iron bridge is also to be erected over the Clyde in room of the Hutchesontown stone bridge.

The Shipbuilding Trade on the Clyde has recovered in a wonderful degree, during the past quarter, from its recent depression. Several merchant vessels have been launched. Messrs. Robert Napier and Co. have commenced the construction of two iron-plated ships for the British Government; they have also in course of construction one iron ram, with a cupola for carrying two heavy guns, and a monitor for the Danish Government. A gunboat for the British Government has also been commenced at the yard of Messrs. Randolph, Elder, and Co. Messrs. Palmer and Co., of Jarrow, have undertaken the construction of an armour-plated monitor for the English Government; this vessel will be fitted with engines of 250 horse-power, which will also be supplied by the same firm.

The great event of the quarter with reference to dock construction has certainly been the opening of one of the Barrow-in-Furness Docks on 19th September. The site of the town of Barrow is separated by a channel from a small island, called Old Barrow Island, which forms the extreme point of the coast against the Walney channel, at its narrowest part, opposite the church on the Isle of Walney. This channel affords a dock accommodation of 105 acres in area, and it has been made use of for the construction of the new docks made by the Furness Railway Company. The first of these, called Devonshire Dock, with an area of thirty acres, and a stone quay of 2,500 feet in length, is the only one yet completed; while the second basin, Buccleuch Dock, has only been finished as far as the stone quay on one side is concerned. These

docks comprise 1½ miles in length of stone quays, and wharves of an area of 100 acres in extent.

On 3rd October a new dock was opened at Belfast, which consists of a large basin 700 feet long by 700 feet wide, called the Abercorn Basin, in which is a new graving dock 450 feet long by 80 feet wide at the coping, and 50 feet wide at the bottom. A new slip has been constructed at Messrs. Inglis' ship-building yard, which is the largest slip on the Clyde. It is 850 feet in length, and capable of accommodating ships up to 2,000 tons measurement, and drawing up to 16 feet forward. It is worked by at wenty-horse power engine and a hydraulic ram.

The British Fishery Company are engaged in the construction of a new harbour on a large scale in the Bay of Wick. This work has now been going on for some years, but owing to the great depth of water in which the breakwater is founded (about 30 feet at low water), and the interruption to the work in consequence of the heavy seas raised by easterly winds, the progress is slow, being only about 200 feet per annum.

It is proposed to spend a sum of 15,000*l.* on improvements of the river Ribble, so as to render it navigable for vessels of a large size, and in the construction of wet docks. A commencement has at last been made with the long contemplated docks at Lynn. The chief portion of the land required for the works has been purchased or arranged for, and the excavation of the diversion of the Fisher Fleet is well advanced. Works undertaken at Harwich, with a view to the improvement and protection of the harbour, have been attended with the best results. Already about four acres of the "beach end" have been washed away, and vessels of light draught can now enter the harbour at high water by the old leading marks.

At Brindisi it has at length been determined to form a dry dock 120 metres in length; the works are to be thrown open to competition, and offers are to be made under the obligation of constructing the basin sufficiently large to receive vessels of 2,000 tons.

Important works are being executed at Barcelona, the most considerable port of Spain on the Mediterranean. The depth of water is being increased to 33 feet, and the port will be protected by two jetties, to the east and west, so that it will comprise altogether a space of 286 acres, into which ships of the heaviest burden and war frigates will be enabled to enter. The cost of these works is estimated at 450,000*l.*

The Northern Lights Commission have determined to erect a new lighthouse on Dune Point, in the Island of Islay, and another at Scurdy Ness, at the south side of the entrance to the harbour of Montrose.

Preparations are being made for the erection of a complete system of lights and beacons along the Chinese coast; in all, fifteen points have been chosen.

American Tube Wells are beginning to attract attention in this country. They are constructed by driving an iron tube, perforated at its lower end, down to where water may be found beneath the surface of the ground. Trials on this plan have been made recently in Manchester and Glasgow; in the former case water was reached in five minutes from the commencement of operations, and in twenty-two minutes a depth of 10 feet had been reached. Several of these Tube Wells have been sent out with the Abyssinian expedition.

Mr. Charles Randolph, of the firm of Randolph and Elder, of Glasgow, has recently patented a new hydraulic propeller for vessels. This appartus consists of a fan, or centrifugal pump, placed in a casing connected with a couple of channels or ducts, leading the one to the head, and the other to the stern of the vessel. The fan-shaft is placed horizontally, and the fan is driven by a simply-arranged engine without reversing gear; the reversal of the action of the fan being accomplished by moving its shaft in the direction of its axis, which brings it alternately to one side or the other of a diaphragm, in a casing communicating with the bow and stern passages on either side of the diaphragm respectively.

An ingenious water-jet pump has recently been designed by Mr. E. Reynolds, one of which is now employed at Messrs. Vickers' works, at Sheffield, for raising water from the race in which the fly-wheel of the engine driving the tyre mill runs. The wheel-race from which the water is raised is 14 feet deep, and the pump is worked by water supplied under a head of 240 feet.

Sir John Brown, of the Atlas Works, Sheffield, signalized his new knighthood by rolling an armour plate 15 inches thick, 20 feet long, and 4 feet wide, which weighs no less than 21 tons.

Mr. Krupp is about to construct at his Works at Essen, a single-acting steam-hammer, far exceeding in size any now in existence. It will have a head weighing 120 tons.

7. GEOGRAPHY.

(*Including the Proceedings of the Royal Geographical Society.*)

The last six months have not been very fruitful in Geographical discovery. More has been done in investigating the works of ancient geographers than in adding to their knowledge.

In Africa Mr. Gerhard Rolphs and M. Miani are crossing the continent in different directions, but with what success tidings have

not yet reached us. In Palestine the exploration under Lieutenant Warren, R.E., is continuing with increased success. Of late the principal attention has been directed to Jerusalem, where the improved feeling manifested by the authorities and people, now they discover that no irreverence is intended, and see that the Arabs under British superintendence conduct themselves with regularity and steadiness, has given facility for investigating many localities hitherto inaccessible to Europeans. A portion of the site of the temple and a few other spots have yielded curious results to the burrowings of the workmen, whilst the Lieutenant and his assistant, Sergeant Birtles, have penetrated beneath the earth up and down and along passages of all sizes, from halls of 200 feet in height, to drains through which a moderate sized man could just crawl. The expedition was nearly coming to an untimely end for want of funds, but of course this only had to be known and understood, when sufficient to keep them at work for some little time longer was immediately forthcoming. It is hoped that before long a tolerably complete plan of the ancient city will be possible, when the interminable disputes of architects and historians who have never been on the spot, and of travellers who know nothing of history and architecture, will be forcibly stopped, and conjecture will give place to certainty. In the meantime we would urge upon all interested in such subjects, the propriety of assisting in a work where every shilling expended shows some definite result.

Abyssinia swallows up all the interest that can be afforded for geographical purposes at the present time. Mr. Robert Lowe complained in his lecture on education at Edinburgh, that more educated men could tell him where Halicarnassus was than where Gondar is. There is not much fear that this ignorance will last long. No doubt educated men, Members of Parliament, and many of her Majesty's Ministers, too, know much more about the geography of Asia Minor than they do of Abyssinia, but they only share in the knowledge and ignorance of the world in general, and of geographers in particular. People naturally know more of places where great events have taken place or great men have lived, than of those localities where hereafter something is to happen. The new maps of the country over which our armies are travelling contain, no doubt, the best information to be obtained (and we would especially point to Mr. Wyld's lately published map), but in these there are immense tracts of land with scarcely a name, perhaps a river put in tentatively, and a camel route crossing an otherwise unmarked district of hundreds of miles. Promises have been given that scientific men shall accompany the expedition, and all the knowledge at the command of the Royal Geographical Society has been employed by the Government. Several books of course have been published on a subject so generally interesting. Besides Sir

Samuel Baker's book on the 'Nile Tributaries,' which was not intended to contribute much that could be useful for the present expedition, a fair account has been given by Mr. Dufton, an observant traveller, and a collection has been put together by Mr. Hotten. The expedition will be accompanied by Dr. Krapf, the missionary, as interpreter, a gentleman well acquainted with both the Amharic and Tigree languages; by Mr. W. Blanford, as geologist; by Dr. Doitch, of the British Museum, as antiquarian and archæologist; and it was said, but it has been since contradicted, by Mr. Clements Markham, as geographer. By making these appointments, the Government have entitled themselves to the thanks of scientific men. It remains to be seen whether a more popular Parliament will support this step in the right direction.

The volcanic disturbances at Santorin have already excited considerable attention. Since our last Chronicle, Canea in Crete, Iceland, and Vesuvius, have been visited by perturbations; Candia, by an earthquake; Iceland and Vesuvius, by eruptions. In the former of these two the outbreak has been in a part of the island far from human habitation, and the extent of the outpouring is as yet unknown, and the site of the disturbance is probably almost inaccessible. In Vesuvius a new crater has been opened, and several streams of lava are issuing from this new mouth.

As we stated at first, a good deal has been done in the way of studying the antiquities of geography. Colonel Henry Yule has published for the Hakluyt Society the accounts of many travellers of the middle ages in Central Asia, and has summed up in an introductory essay the information to be gained therefrom. His work is entitled 'Cathay, and the Way thither.' A book called 'Heroes of Discovery,' by S. Mossman, gives lives of Magellan, Cook, Park, Franklin, and Livingstone. These are interesting and inciting to young people to follow in the footsteps of the "Heroes." M. Léonce Angrand has been studying the monuments of Peru with a view to discovering the condition of civilization of the ancient inhabitants, and has lately published the result of his researches. Reimer, of Berlin, has issued a map of great philological and ethnological value, by Herr Kiepart, showing the nationalities of the various Austrian States. Messrs. Macmillan also have published an atlas, in the form of a book, a useful and portable work for reference. Guide books to Lough Corrib, by Sir W. Wilde, and a 'Murray' for Yorkshire have also appeared.

Proceedings of the Royal Geographical Society.

The President, Sir Roderick Murchison, in his annual address at the commencement of the session of 1867–68, confined his attention almost entirely to three points:—first, the fate of Dr.

Livingstone, and the boat expedition sent in search of him; secondly, the geography of Abyssinia; thirdly, the exploration of Central Greenland by Mr. E. Whymper. Mr. Young, in command of the expedition sent by the Government on the track of Livingstone, had met with every facility from the authorities at the Cape, had engaged a negro crew, entered the Congoni mouth of the Zambesi, and was progressing towards the accomplishment of his errand with all due speed. Still, no news could be expected from him until February or March in next year. In the meantime it is impossible to tell whither Livingstone may have betaken himself. With regard to the geography of Abyssinia, the value of this Society was likely to be now felt. Mr. Clements Markham, the honorary secretary, has prepared an account of the discoveries of the early Portuguese travellers, and the Society has been the centre around which all the geographical knowledge, now so important to the Government embarking in an expedition of which they are unable to realize the difficulties, has been collected, the whole nation in this way participating in the benefit accruing to scientific research, for which they are so unwilling to pay. Already the Topographical Department, under Sir H. James, have been busy in systematizing the information afforded by former travellers, whilst private geographers, Mr. Wyld, Mr. Keith Johnston, and Mr. Peterman have been engaged on maps that will elucidate the passage of the English army. Sir Samuel Baker has contributed somewhat to our knowledge of the water system of this country, and has especially shown that the fertilization of Egypt by the waters of the Nile is attributable to the soil carried down the Abyssinian tributaries, rather than to the more regular sources of the constant flow which traverse larger portions of the continent. It is expected that some new papers will be read on various explorations of Central America, and it is to be hoped that before long an account will be given by Mr. Whymper, of Greenland, whence he has just returned, having accomplished an inland journey not quite so extensive as he had intended, but which will considerably increase our knowledge of the animal and vegetable life of the interior of that country.

The first paper read this session was by Mr. Clements Markham, "On the Portuguese Expeditions to Abyssinia, from the Fifteenth to the Seventeenth Centuries." All that was known of Abyssinia down to the time of Bruce was the result of the discoveries of the Portuguese, who had performed wonders in discovery for such a small nation. King John II. despatched two of his subjects, one of whom penetrated to the court of the Negus or Emperor Alexander, in 1450, where he was detained by this predecessor of Theodorus, and never again allowed to quit the country;—rather a bad omen for Colonel Cameron and Mr. Rassam. This Portuguese was alive in 1520, when a second embassy arrived, who were detained six years,

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after which some members were dismissed. In answer to a request sent to Lisbon, a small Portuguese force was sent in 1541, to assist the Abyssinians against the Moors. They lost their leader and were defeated in the service, and after that were treated with great ingratitude by those whom they went to assist. They left behind them a fortified convent of Jesuits, who remained until they were expelled from the country in 1633, having made scarcely any converts from the primitive form of Christianity held by the natives.

At the next meeting of the Society, letters were read from Dr. Kirk and the Vice-consul at Zanzibar, giving some information about the existence of Dr. Livingstone. It seems that a native had arrived at the coast from Bagamoyo, who reported that when with a party who had travelled the regular route to Wemba and Maranga, he had seen a white man, who arrived at the village the caravans were passing through, with a party of thirteen blacks, which is the number of the young negroes Dr. Livingstone is known to have had with him. The white man was not a trader, for he refused ivory offered to him. On being shown a number of photographs, the native recognized one of Dr. Livingstone as that of the white man he had met, though he passed over another better likeness of the same person without remark. Dr. Kirk hoped shortly to see the head man of the caravan and the others who accompanied him, and thus obtain some further information—but this is sufficient to put an end for ever to the account of the man Moosa, whose lies it is extraordinary should ever have taken possession of men of understanding and knowledge of the subject. An artificial excitement on this one topic of the exploration of Central African lakes, engendered within the walls of the Royal Geographical Society, is the only explanation of the phenomenon that clever, cautious, and well-informed persons should be taken in by the mendacious accounts of men proved to be utterly unworthy of credit, and when once committed to an opinion, these men have maintained with sophistical arguments the opinion they had uttered, at the peril of their reputation for common sense.

A paper by Mr. Collinson, on a hitherto unexplored part of Nicaragua demonstrates the possibility of a railroad over that portion of Central America. The whole ground had been traversed, the gradients are moderate, the climate comparatively good, and the distance not great.

8. GEOLOGY AND PALÆONTOLOGY.

(Including the Proceedings of the Geological Society.)

The last volume (xxii.) of the Memoirs of the Royal Academy of Sciences of Turin contains an important contribution to Fossil Botany, entitled "Matériaux pour servir à la Paléontologie du Terrain Tertiaire du Piémont. Première Partie: Végétaux." By M. Eugène Sismonda. The descriptions, and especially the numerous figures, of these Tertiary plants must possess the highest interest for botanists generally, and must be of great utility to those who make fossil floras their especial study. M. Sismonda has been able to distinguish in the plant-bearing deposits of Piedmont five different floras: namely, (1) Eocene, (2) Lower Miocene, (3) Middle Miocene, (4) Upper Miocene, and (5) Pliocene.

The Eocene flora is chiefly characterized in Italy by Fucoids, the species being but three in number: *Chondrites Targionii*, *C. furcatus*, and *C. arbuscula*. This poverty is not surprising when it is considered that the animal-remains of the same period are not at all abundant. The Lower Miocene deposits are very rich in plant-remains, and some of them include considerable beds of lignite. They belong to two classes: namely, (1) the lacustrine and lignitiferous beds; and (2) the litoral marine deposits, almost barren of lignite. The distribution of these two classes enables one to trace the Italian shore of the sea of the Older Miocene Period. Some discussion has arisen regarding the division of the Tertiary epoch to which these beds properly belong; but, as with all such discussions, no satisfactory termination seems possible; M. Sismonda has therefore done wisely, we think, in considering the two terms (Upper Nummulitic and Lower Miocene) as synonymous. The Middle Miocene deposits are the most rich in plant-remains of any in Italy; but they contain no beds of lignite. Their most celebrated locality is the Superga, near Turin, where no less than fifty species have been discovered. The deposit at Sarzanello appears to be slightly younger than that of the Superga. The Upper Miocene deposits are likewise rich in species, sixty-six being described by the authors. The Pliocene flora is very poor.

The interest of a critical comparison between the plants of these Miocene deposits and those of the same age found on the other side of the Alps would be very great, and would go far towards either proving or disproving the theory of the recent elevation of that range of mountains.

A new series of the 'Boston Journal of Natural History' has recently been commenced under the title of "Memoirs read before the Boston Society of Natural History," and in the first volume is an elaborate paper by Dr. A. S. Packard, jun., on the Glacial

Phenomena of Labrador and Maine. On the Laurentian and Huronian rocks of the Labrador Peninsula few superficial deposits occur, the region having evidently been exposed to the most intense denuding action of glaciers, prolonged over a period much longer than even in Canada. The whole of the Plateau has been moulded by ice to a height of at least 2,500 feet above the level of the sea; but owing to the extensive weathering of the rocks, glacial grooves and scratches occur very rarely below a height of from 500 to 800 feet from the sea-level, up to which point the action of the waves and of shore-ice has obliterated all traces of striæ, and also of loose drift. It is also important to notice that the present contour of the coast, from the sea-level to a height of 500 feet, also extends to at least 300 feet below the surface of the water. The whole surface of the country is strewn thickly with boulders, especially above the height already mentioned. About 400 feet above the present coast-line are some fine examples of raised beaches and rock-shelves, representing ancient coast-lines; and there are others, apparently of the same origin, at great heights in the interior of the southern part of the Peninsula. Some beaches were also observed by the author, apparently very recently raised above the sea-level, so as to be just beyond the reach of the waves; and he therefore infers that the land is slowly gaining on the sea. At the mouths of certain rivers, and situated just above high-water mark, there occur deposits of clay, known as Leda-clays, containing marine and estuarine fossils. The author draws some interesting conclusions from these phenomena, and supplements his paper by an account of the recent invertebrate fauna of the region.

In the same volume is a very able paper, entitled "An Inquiry into the Zoological Relations of the first-discovered traces of Fossil Neuropterous Insects in North America; with remarks on the difference of structure in the Wings of living Neuroptera;" its title is a sufficient index of its scope and character.

Dr. J. S. Newberry has examined the fossil plants from the Chinese coal-bearing rocks, discovered by Mr. Pumpelly, and has determined them to be of Mesozoic age. The collection includes Cycads of the genera *Podozamites* and *Pterozamites*, closely allied to known European and American species, if not identical with them. There are also representatives of the genera *Sphenopteris* and *Hymenophyllites*, and a species of *Pecopteris*, which is doubtfully referred to the well-known *P. Whitbiensis*. The *precise* age of the beds cannot be determined with certainty; but they are either Jurassic or Triassic.

The thirteenth volume of the 'Proceedings of the Somersetshire Archæological Society' contains a valuable paper "On the Middle and Upper Lias of the South-west of England," by Mr. Charles

Moore, which includes figures and descriptions of a large number of new species.

Another important descriptive paper, "Monographie paléontologique et géologique de l'étage Portlandien des Environs de Boulogne-sur-Mer," by MM. de Loriol and Pellat, is contained in the nineteenth volume of the 'Mémoires de la Société physique d'Histoire naturelle de Genève.' It is necessary to call attention to such memoirs, but abstracts of their contents can scarcely be given in our Chronicles.

Mr. W. H. Baily, acting palæontologist to the Geological Survey of Ireland, has commenced the publication of a work entitled 'Figures of Characteristic British Fossils with Descriptive Remarks.' The first part contains 10 plates and descriptive letter-press, embracing the characteristic fossils of the strata from the Cambrian to the Caradoc inclusive. This work will, no doubt, be of very great assistance to amateur geologists and to students. The Council of the Geological Society indeed recognized this fact, by awarding to the author the Wollaston Donation-fund at their last anniversary to assist him in publishing it. The author's reputation as a practical palæontologist and draughtsman is sufficient guarantee that the fossils will be judiciously selected and correctly figured.

M. Barrande has issued another volume of his great work on the Silurian fossils of Bohemia, which is devoted to the description and illustration of the Pteropoda, including no less than 68 distinct species, and 7 genera out of the 9 known to occur in Palæozoic rocks. The species of Pteropoda are known to have been very numerous in the Silurian seas; they are almost absent from Mesozoic deposits, but re-appear in the Tertiary; and in the existing fauna there are certain forms which have a striking analogy with those from Palæozoic deposits. M. Barrande asks the question whether this intermittence be real or apparent, that is to say, is it due to the Mesozoic Pteropods having been unprovided with a shell? If this be the case, another question suggests itself to him, namely, why is it that this order is the only one which, during its long "struggle for existence," successively carried, resigned, and resumed its testaceous covering? Such questions as these are much more easily asked than answered; but they nevertheless possess an interest which is almost a charm for those who are endeavouring to discover something of the real philosophy of palæontology.

The fourth edition of Sir R. I. Murchison's 'Siluria' has been published during the past quarter; but we must reserve our remarks on this important work until our next number.

The 'Geological Magazine' for September opens with a most interesting notice by Principal Dawson, "On some Remains of Palæozoic Insects recently discovered in Nova Scotia and New Brunswick." These insects have been discovered in Carboniferous

and Devonian deposits; in the former have been found representatives of the orders *Neuroptera, Orthoptera,* and *Coleoptera,* in England, Westphalia, and the Western States of America; and last year Mr. Barnes, of Halifax, found a wing of a Neuropterous insect belonging to the *Ephemerina* on a piece of shale, partly covered by a frond of *Alethopteris lonchitida.* The Devonian insects consist of four species, all of which appear to be Neuroptera, although two of them cannot be referred to any existing family of the order. This paper is followed by one "On the Remains of Insects from the Coal-measures of Durham," by Mr. Kirkby, who describes portions of the wings of two Orthopterous species. Both authors draw attention to the fact that here again we have evidence of the Palæozoic Insects being synthetic types; in other words, the ancient genera possess combined certain characters which in recent Insects are found in distinct groups, either genera, families, or even orders. The other papers in this number are, "Railway Geology, No. 1," by Mr. D. Mackintosh, and "The Moulded Limestones of Furness," by Miss E. Hodgson, the latter being a description of the weathering of limestone by chemical atmospheric influences.

The October number commences with a paper "On the Chemistry of the Primeval Earth," by Mr. D. Forbes, in which the author expresses his dissent from some of the views advocated by Dr. Sterry Hunt in his lecture at the Royal Institution mentioned in our last Chronicle, especially Dr. Hunt's conclusion that the earth is "a globe solid to the core, which had solidified from the centre outwards to the exterior."* Mr. Forbes also combats Dr. Hunt's opinion "that granite is in every case a rock of sedimentary origin," and follows him closely in his argument on this head also. We cannot do justice to this subject in a Chronicle, and we therefore refer those interested in it to the reports of Dr. Hunt's lecture, and to this very able reply by Mr. Forbes. Professor J. Morris contributes an important paper, "On the Ferruginous Sands of Buckinghamshire, with remarks on the distribution of the equivalent strata," which is chiefly descriptive; the author, however, expresses his opinion that the Purbeck and Portland strata probably never extended far beyond their present limits, which is a point of some interest. The other original articles in this number are (1) "On the Gorge of the Avon at Clifton," by Mr. Jukes, in which it is shown that the same explanation, so ably given by the author, which accounts for the gorges of the rivers in the south of Ireland, is equally applicable to the Avon; (2) "On Subaërial Denudation, and on Cliffs and Escarpments of the Chalk and Lower Tertiary

* This opinion was held by the late Mr. Hamilton, although he supported it by a different argument from that advanced by Dr. Sterry Hunt. See 'President's Address to the Geological Society,' 1866; and 'Quart. Journ. Science,' No. xi., p. 420.

Beds" (continued in the next number), by Mr. Whitaker; and (3) "On some new Terebratulidæ from Upware," by Mr. J. F. Walker.

The first paper in the November number is by Mr. Ruskin; it is a continuation of the one in the August number, "On Brecciated Formations." Like all, or nearly all, Mr. Ruskin's geological papers, it is a burlesque of a scientific essay. For instance, "I suspect that many so-called 'conglomerates' are not conglomerates at all, but concretionary formations." Mr. Ruskin gives an example, namely, "red, rounded, flint 'pebbles,' much divided by interior cracks, enclosed by a finely crystallized quartz," and he regards the "pebbles" as "secretions—the spots on a colossal bloodstone." Mr. Guppy has a paper on West Indian Geology, to the conclusions in which we should think other investigators will not subscribe. Dr. Von Koenen gives a valuable paper on the Belgian Tertiaries, in which he mentions that M. Cornet has discovered his error respecting the "Calcaire Grossier" of Mons, and is about to rectify it. Mr. Whitaker concludes his paper mentioned above, and Mr. Belt commences one "On the Lingula-flags or Ffestiniog Group."

These three numbers of the 'Geological Magazine' will thus be seen to contain many papers of great value, and we congratulate the editors on their success in sustaining its high character.

Proceedings of the Geological Society.

Several able communications on interesting subjects are contained in the November number of the Society's Journal, and demand some notice from us. Capt. Spratt's paper "On the Bone-caves of Malta" places before us in a very clear manner the points of agreement and of difference observed to exist between some of the Maltese caverns. He describes three, namely, those of Maghlak or Crendi, of Zebbug, and of Melliha. The first and last of these were found to contain remains of *Hippopotamus* (*H. Pentlandi*), with no traces of Elephant-remains. The Zebbug cavern, on the contrary, yielded abundant remains of the pigmy elephant of Malta, associated with some of a larger species, but without any indication of *Hippopotamus*. Notwithstanding this very pronounced distinction, there is one point of agreement noticed as existing between the Maghlak or Crendi and the Zebbug caverns. In the former, the stalagmite containing the Hippopotamus-remains was overlain by a layer without fossils, and this again by one containing bones and teeth of a large Dormouse (*Myoxus Melitensis*), bones of Birds, and land-shells of existing species. In the latter, the sandy clay containing the Elephant-remains also yielded bones and jaws of *Myoxus Melitensis*, bones of two large species of Swan, &c. We thus obtain an indication of the relative ages of the Hippopotamus and the Elephant, the former being apparently the most ancient.

Capt. Spratt discusses at some length the conditions under which an amphibious animal like the Hippopotamus could have lived on the island of Malta, believing that it was at that time at a much higher elevation, and was joined to Sicily and the Italian peninsula, but separated from Africa by a very narrow strait. An uplift of 250 fathoms would produce this result. The admixture of fragments of remains of Elephant and of marine animals with entire shells of terrestrial mollusks in the red earth, occurring in the fissures and hollows in various parts of Malta, the author attempts to explain by means of a "wave of translation." Geologists of the present day are very sceptical about such abnormal occurrences; but very recently, for a few days, it seemed as if the fate of the Island of Tortola had proved them to be terrible realities, whose rarity was mercifully proportioned to their destructive power.

A useful paper, by Mr. Tate, "On the Fossiliferous Development of the Zone of *Ammonites angulatus* in Great Britain," contains an account of the conditions under which this zone occurs in Lincolnshire, Warwickshire, Gloucestershire, Glamorganshire, Dorsetshire, and in Ireland, and a complete list of the fossils (corals excepted) which have been found in it. Mr. Tate also swells the list of Mr. Tawney's opponents, and discusses the relations and age of the Sutton Stone, taking exception also to Mr. Tawney's determinations of some of the fossils. His conclusions are, that the Sutton Stone is a part of the Lower Lias, and that its fossils belong to the Hettangian fauna. He also states that he regards the Sutton Stone and the Southerdown beds to be, jointly, the equivalents of the beds intermediate between the White Lias and the zone of *Ammonites Bucklandi*.

Another paper by Mr. Tate, "On the Lower Lias of the North-east of Ireland," and one by Mr. Burton, "On the Rhætic Beds near Gainsborough," will be read with interest by those interested in the geology of the districts described in them.

Dr. Duncan and Mr. Thomson have a paper on a new genus of corals (*Cyclophyllum*), which possesses a remarkably complex structure, and presents many points of interest in a classificatory point of view.

Dr. Dawson's note on the discovery of a new Pulmonate Mollusk [*Zonites* (*Conulus*) *priscus*] in the coal-formation of Nova Scotia, presents a most interesting confirmation of his former discovery of land-shells in those Palæozoic strata. As the *Pupa* formerly described did not differ in any essential respect from the modern representatives of that genus, so in this case we have a shell which can be referred to a subgenus of Zonites (*Conulus*), which includes several recent species, *Zonites* itself being a subdivision of the group of genera commonly termed Helix.

A paper on the Chemical Geology of the Malvern Hills, by

the Rev. Mr. Timins, contains the results of nearly one hundred analyses of the rocks occurring in that range. They comprise the following varieties: (1) Lava and Volcanic Ash overflowing, or interstratified with, the Black Shale; (2) Eruptive rocks of the Hollybush Sandstone; (3) Shales; (4) Bedded Traps, Lavas, and Felstones of the Herefordshire Beacon; (5) Felstones north of the Herefordshire Beacon; (6) Quartzo-felspathic veins; (7) Trisilicated Felspathic veins; (8) Felspathico-hornblendic rocks; and (9) Intrusive Traps. Some of the author's conclusions are of general interest, especially: that the relative proportions of the several bases often characterize particular localities; that the chemical composition of the eruptive rocks does not vary according to their age; that the atomic proportion of the silica to the bases appears to be *highest* in the *largest* masses of trap (but this law, though very general, is not invariable); that in the same masses of trap there is an appreciable increase in the silica towards their centres; that the *primary source* of all the trap-rocks in the Malvern Hills was nearly a bisilicate. There are many other important inferences which we have no space to mention, and, indeed, this paper requires a most careful study to be properly understood or appreciated.

Mr. Townsend M. Hall's paper on the Relative Distribution of Fossils throughout the North Devon series, contains a valuable table showing the range of the species in the fossiliferous groups, both geologically and geographically.

In a paper on the sources of the materials composing the White Clays of the Lower Tertiaries, Mr. George Maw advocates their derivation from the chalk, by the gradual solution of the calcareous matter, the aluminous and siliceous portions being left, and forming the white clays in question. It has been generally considered that these clays have, in many instances at least, been derived from the decomposed felspar of granite; but Mr. Maw points out that Kaolin, which is the result of the decomposition of felspar, is perfectly implastic,—a character entirely opposed to that of the white Tertiary clays. An important chemical fact bearing upon this matter is, that the clays in question contain the alumina in a larger proportion to the silica than felspar would afford. Many other facts are urged by Mr. Maw in support of his theory, and he gives numerous analyses of clays, chalk, and chalk-marl, made chiefly by Dr. Voelcker, Prof. Way, and Mr. C. D. Blake, which support his statements respecting their chemical composition.

The last paper in this number which we have space to notice is one "On the Structure of the Postglacial Deposits of the South-east of England," by Mr. S. V. Wood, jun., in which the author gives an epitome of the results arrived at by him after a survey of the region mentioned, which results, and the maps and sections on which they are founded, are given fully in a manuscript memoir

deposited by him in the Geological Society's Library. The principal view advocated is, that the "entire valley-system of the East of England originated in centres of arc-like or curvilinear disturbance, which immediately preceded the elevation of the bed of the sea from which was deposited the wide-spread deposit of Boulder-clay forming the latest of the Glacial beds of the South of England." We are glad to see that Mr. Wood now recognizes the ambiguity of the terms Upper Drift, Middle Drift, &c., which we pointed out in noticing a former paper of his, and has substituted for them the terms Upper Glacial clay, Middle Glacial beds, &c. Many other points of interest are also discussed, especially the relations of the Thames valley-gravel, the Brick-earth deposits, &c., for which we must refer our readers to the paper itself.

On December 1st the Society published a bulky Supplement number, the description of which we must reserve for our next Chronicle.

9. MINERALOGY, MINING, AND METALLURGY.

Mineralogy.

Among British mineralogists no one has latterly been more active, whether in laboratory work or in literary work, than Mr. David Forbes, F.R.S. Without referring to his writings on Chemical Geology, which, however, are full of interest to the mineralogist, it will be sufficient in this place to call attention to his purely mineralogical work. In introducing the first part of his "Researches on British Mineralogy,"* Mr. Forbes takes occasion to contrast the present backward state of the science in this country with the honourable position which it occupied in the early part of this century. The chemist now-a-days is attracted by the organic branch of his science rather than by mineral chemistry, while the geologist is usually allured by palæontological research; and hence but few labourers enter the field of Mineralogy. To correct this state of things, and to develop a wholesome taste for the study, Forbes protests against the too-prevalent notion that Mineralogy is occupied exclusively with the dry enumeration of species, and with the description of their physical characters and chemical composition. Taking a higher stand-point, he maintains that minerals should properly be studied with reference to their mode of occurrence, origin, paragenesis, and especially the relations of their associated rocks. When thus prosecuted, the study cannot fail to prove a valuable aid both to the geologist in his examination of rock-masses in the field, and to the miner in his investigation of the

* 'Philosophical Magazine,' Nov., 1867, p. 329.

laws of mineral deposits. As an illustration of these advanced views, our author refers to his own researches which, although confessedly imperfect, tend to the remarkable conclusion that, in eruptive rocks, most minerals present themselves under similar conditions, accompanied by the same associated minerals, and in rocks of corresponding geological age. Hence he believes that certain minerals may serve to identify contemporaneous outbursts of eruptive rocks, in the same way that fossils serve to determine the age of sedimentary deposits. When, as often happens, the same mineral occurs in rocks of different age, he finds that in each situation it is marked by distinctive characters of its own, either physical or chemical. Thus, mica is distributed through rocks varying widely both in character and age; but while in granite it usually occurs as muscovite or potash-mica, in limestone and serpentine it appears as phlogopite or magnesia-mica, in zirconsyenite as astrophyllite or titaniferous mica, and in volcanic rocks as biotite. Generalizations of this kind are sufficient to show that the field of labour which Mineralogy affords is after all not so unattractive as many are inclined to think. As an earnest that the author himself is willing to bear a fair share of the work, he gives us a paper devoted chiefly to a notice of British Gold. Although public attention has from time to time been directed to the occurrence of gold in this country, and considerable excitement has been aroused by the recent workings in North Wales,* no analysis of British Gold has hitherto been recorded. Mr. Forbes has therefore visited the Welsh mines, and has analyzed specimens from the celebrated Clogau lode with the following results:—

	I.	II.
Gold	90·16	89·83
Silver	9·26	9·24
Iron and Copper . . .	trace.	trace.
Quartz	0·32	0·74
Loss	0·26	0·19
	100·00	100·00

The metal from this mine is therefore an alloy of gold and silver, closely agreeing with the formula—$Au_6 Ag$. After fully describing the character of the lode in which it occurs, Mr. Forbes discusses the probable age of the gold. He has already classified all known auriferous veins in two great groups—the *older* or *granitic*, which were formed at some time between the Silurian and the Carboniferous period, and the *newer* or *dioritic*, probably of Cretaceous age: it is to the former of these classes that the author is inclined to refer the gold-veins of North Wales.

* See a paper in this Journal on "British Gold with especial reference to the Gold Mines of Merionethshire, by Robert Hunt, F.R.S.," vol. ii., p. 635.

Mr. Forbes has also analyzed some Welsh stream-gold from the river Mawddach, about eight miles above Dolgelly. The metal yielded 84·89 per cent. of gold, and 13·99 of silver.

In the "Rowley Rag," a well-known basaltic rock from the South Staffordshire coal-field, the same chemist has detected minute grains of a black mineral, which, on analysis, proved to be *Titanoferrite*, or titanate of iron, having the following composition:—

Titanic acid	34·28
Oxide of iron	65·72
	100·00

Mr. Forbes brings his paper to a conclusion by noticing a newly-discovered silver ore from the Foxdale mines in the Isle of Man. This ore, which contains 13 per cent. of silver, occurs in sufficient quantity to form an object of considerable commercial importance. The mineral is an argentiferous fahlerz, such as the Germans would call *Weissgiltigerz*, but which the author describes under the rarely used name of *Polytelite*.

Among the recent reports on the advancement of French literature and science, published under the direction of the Minister of Public Instruction, it comes within our province to notice only the "Report on the Progress of Mineralogy," drawn up by M. Delafosse.* By giving a *résumé* of nearly all the mineralogical work which has been conducted in France within the last quarter of a century, the reporter shows that his countrymen, led by such men as Dufrénoy and Descloiseaux, have played a part in the advancement of our science by no means discreditable to the fatherland of Haüy and De l'Isle.

Those who love to speculate on the ultimate constitution of matter, and to study the recondite laws of crystallogeny, will find much to interest them in an essay on the "Molecular Constitution and Growth of Crystals," recently published by Dr. Adolph Knop, of the Polytechnic School of Carlsruhe.†

It is well known that certain varieties of sandstone enjoy to a limited extent the curious property of flexibility. Such flexible sandstone—known to the mineralogist as *Itacolumite*—is usually found in association with the diamond, and, so far as our knowledge at present extends, appears to be restricted to the mining districts of Brazil and the Ural Mountains, to the neighbourhood of Delhi in India, and to the gold-bearing States of Georgia and North Carolina. As itacolumite always contains more or less disseminated talc or mica, its flexibility has usually been referred to the presence of these elastic scales. This opinion has, however, been lately

* 'Rapport sur les progrès de la Minéralogie.' Paris, 1867. 4to. pp. 97.

† 'Molekularconstitution und Wachsthum der Krystalle.' Leipzig, 1867. 8vo. pp. 96. 48 woodcuts.

opposed by Dr. Wetherill, whose observations show that while the micaceous or talcose mineral determines the cleavage of the rock, it bears no relation whatever to its flexibility. "This flexibility," says the doctor, "is due to small and innumerable *ball-and-socket joints.*" The grains of silica composing the sandstone, instead of cohering into one uniform mass, are arranged in definite groups separated from one another by intervening cavities; and when the projections of one cluster engage in the corresponding cavities of a neighbouring group, there is produced an articulated structure, permitting motion within certain limits. By experiment the author has found that grains of sand, if saturated with petroleum, will cohere into groups separated by such intervening cavities; and hence, applying this fact, he conceives that the very gradual removal of the hydrocarbon might be attended with the separation of crystallized carbon in the form of diamond. As the jointed structure is quite characteristic of flexible sandstone, the author proposes to introduce the term *Articulite*—apparently a needless multiplication of synonymes since the mineral is already well-known as Itacolumite.*

Rarely does the mineralogist meet with a crystal presenting that perfect symmetry of form which the laws of crystallography demand. As a rule crystals are more or less distorted, the appearances presented by such irregularities being in many cases extremely deceptive. Some curious examples of such monstrosities have lately been described by Dr. Scharff, in a paper "On Deformed Crystals of Rock Salt."† Instead of the six faces of the cube being all equally developed, certain faces were drawn out in some crystals and depressed in others, thus giving rise on the one hand to prismatic forms and on the other to tabular crystals. Moreover, the angles of the cube occasionally deviated from right angles—an irregularity giving a rhombohedral aspect to the crystal. In all cases, however, the true form was easily discoverable by the cubic cleavage.

In a specimen of Wolfram from Auvergne, Dr. Phipson has detected the presence of Columbite. When the mineral is attacked by aqua regia the wolfram is dissolved, leaving an insoluble residue, which consists of angular fragments of a black non-magnetic substance having the composition of Columbite.‡

Some curious numerical relations between the atomic constitution of a mineral and the symmetry of its crystalline form have recently

* "Experiments on Itacolumite (Articulite), with the Explanation of its Flexibility and its Relation to the Formation of the Diamond."—'Silliman's American Journal,' xliv., No. 130, p. 61.

† 'Ueber missbildete Steinsalz-Krystalle.' Leonhard und Geinitz's Jahrbuch. 1867. Heft vi., p. 670.

‡ "Sur la présence du Columbite dans le Wolfram."—'Comptes Rendus,' 1867, No. 10, p. 419.

been worked out by the American mineralogist, Professor Dana.* Hitherto we have been unable to explain why a given substance should crystallize in a certain definite system in preference to any other; why, for example, a piece of tin-stone should invariably crystallize in forms belonging to the tetragonal system rather than in those of the other crystallographic groups. Dana shows that this symmetry of form is immediately connected with the chemical constitution of the mineral. Taking, as an example, this tetragonal or pyramidal system, we may remind the reader that the solids belonging to this order are bounded by 4, 8, or 16 sides; and hence the symmetry of the forms is characterized by the number 4, or a multiple of 4. Now it is found that in most minerals belonging to this system the number of atoms of the electro-negative or non-metallic element is in like manner 4, or a multiple or submultiple of that number. Hence a piece of tin-stone crystallizes in tetragonal forms, in virtue of its constitution as a binoxide, $Sn\ O_2$; the number of atoms of the electro-negative oxygen being 2, a submultiple of 4. So again, zircon, wulfenite, scheelite, and schee-litine, are all tetragonal species, each containing 4 atoms of oxygen, their formulæ being respectively—$Zr\ O$, $Si\ O_2$; $Pb\ O$, MO_3; $Ca\ O$, WO_3; and $Pb\ O$, WO_3: or, combining the oxygen of the acid with that of the base, according to the fashion of modern chemists, their composition may be expressed by the following formulæ, which more clearly show the 4 atoms of the element in question—$Zr\ SO_4$, $Pb\ MO_4$, $Ca\ WO_4$, and $Pb\ WO_4$.

Turning to the hexagonal or rhombohedral system, we find the relations to be equally curious. The symmetry of this system is related to the number 6; its prisms, pyramids, and other forms, being bounded by 3, 6, 12, or 24 sides. Here the number of atoms of the electro-negative element is consequently 3, or a multiple of 3. Thus, the sapphire and the ruby—varieties of crystallized alumina —assume hexagonal forms, since alumina is a sesquioxide containing 3 atoms of oxygen, $Al_2\ O_3$. In like manner specular iron-ore is hexagonal, being a sesquioxide of iron, $Fe_2\ O_3$. The same is the case with the large class of rhombohedral carbonates, including those of lime, magnesia, and the protoxides of iron, manganese, and zinc; forming the species known respectively as calcite, magnesite, chalybite, diallogite, and calamine ($Ca\ CO_3$, $Mg\ CO_3$, $Fe\ CO_3$, $Mn\ CO_3$, $Zn\ CO_3$.)

While the professor thus establishes his position with regard to the tetragonal and hexagonal systems, he is by no means so happy in his attempts to deal with the other orders. In the cubic system the number of atoms of the electro-negative element appears to be

* "On a Connection between Crystalline Form and Chemical Composition, with some Inferences therefrom."—'Silliman's Journal,' xliv., No. 130, p. 89; 'Phil. Mag.,' p. 178.

far from constant, while in the oblique systems the results are so discordant as to show at once that their symmetry is dependent on something more than the mere chemical constitution of the species. For other illustrations of Dana's curious theory, and for the manner in which he overcomes difficulties and reconciles discrepancies, the reader must refer to the original memoir already quoted.

In a subsequent paper* Professor Dana follows up his subject, and discusses the chemical composition of the mineral silicates, reducing this complex class of bodies to two well-defined groups—the unisilicates and the bisilicates.

Yet a third paper by this indefatigable author claims the attention of the mineralogist.† The present state of mineralogical nomenclature undoubtedly calls for reform, and Dana does not hesitate to take the first step towards effecting so desirable an object. Advocating the uniform adoption of the termination *ite*, he proposes to change the existing names of minerals in all cases where it can be done without great inconvenience. Such a change has indeed been contemplated by other mineralogists, who have ventured to write galena *galenite*, and fluor *fluorite*. Tracing the origin of this ending *ite* to the Greek and Roman naturalists, our author shows by examples from Pliny that every variety of name now applied to minerals was then in vogue, with the single exception of that introduced in honour of individuals—a class of names which, originating with Werner, has latterly grown to vast proportions. Dana further shows that it is chiefly the French mineralogists who have to answer for that want of systematic termination which disfigures our present nomenclature. Unfortunately, the Abbé Haüy was extremely careless in this respect—"giving names to minerals as a gardener might to his varieties of pinks and roses." To show his utter disregard of uniformity, attention may be called to the following examples of his word-coining:—amphi*bole*, anal*cime*, cymo*phane*, diall*age*, dipy*re*, epido*te*, harmo*tome*, ido*crase*, meso*type*, pleona*ste*, sphe*ne*, &c. Introduced under the prestige of so eminent an authority as Haüy, such names were at once accepted in spite of their incongruous terminations; and many subsequent mineralogists in France, following the example of their great master, have indulged in equal laxity of expression. But while the French mineralogists have thus troubled the science with their neglect of systematic nomenclature, it is pleasing to observe the persistence with which the Germans have adhered to the use of the termination *it*. Even amid the multitude of minerals named by the veteran species-maker Breithaupt, this canon is but rarely departed from; the most notable departures being in the case of the mineral gemini, Castor and Pollux, and of

* 'Silliman's American Journal,' xliv., No. 131, p. 252.

† Ibid., p. 145.

the felspars—orthoclase, oligoclase, &c. In advocating a uniformity of termination, the professor would not seek to alter such long-established names as quartz, garnet, diamond, and the like. After all, the names requiring amendment are comparatively few in number, and all of modern introduction, none of them dating beyond the last sixty years. If any alteration is really contemplated, the sooner it is accomplished the better: "Mineralogy," says the professor, "is far from being so stiffened with age as not to admit of progress in the direction contemplated."

Another point insisted upon by Dr. Dana is the necessity for a distinction between the names of simple minerals and those of *rocks* or mineral-aggregates, a distinction which could easily be marked by terminating the latter in *yte*, as already done in the case of *trachyte*.

Having devoted so much space to an analysis of these important papers, our remaining notices—relating chiefly to so-called new species,—must necessarily be brief. Among the rubbish-heaps of an old silver-lead mine worked by the Romans near Paillières, in the Dept. du Gard, there has been detected a new mineral, to be called *Pastréite*, in compliment to the President Pastré, of Marseilles: it occurs as an amorphous yellow substance, and is apparently an impure hydrous sulphate of iron containing arsenic and lead.*

Stetefeldtite is the name by which Mr. Riotte, a German mining engineer in Nevada, proposes to distinguish a new silver-bearing substance found in that state. It appears to be a sulphide of silver and copper, with an antimoniate of copper and iron.† Herr Igelström describes two minerals from the iron-mine of Langban, in Wermland, Sweden: one under the name of *Pyroaurite*—in allusion to its behaviour before the blowpipe; and the other, as *Lamprophane*.‡ A new mineral-resin, remarkable for its occurrence in hexagonal crystals, has received the name of *Valáite*, after Herr Vála.§

Under the name of *Cyrtolite*, Mr. W. T. Knowles notices an American mineral, which is apparently a hydrated silicate of zinc with the protoxides of iron and of the cerium metals.‖ An American iron ore, mistaken for red hæmatite, has been referred by Professor Brush to the rare species called *Turgite* by Hermann, and *Hydrohæmatite* by Breithaupt.¶ Mr. J. P. Cooke has lately examined several chloritic minerals from the chrome-iron mine of Texas, Pa.; but his observations simply confirm those already published by Descloiseaux.**

Several analyses of potash-micas have been made by Professor

* Verhand d. naturhist. Vereins d. preuss. Rheinlande. xxiii., p. 17.
† Berg-und Hüttenmän. Zeitung. 1867, No. 30, p. 255.
‡ Leonhard's Jahrbuch. Heft V., p. 607.
§ Jahrb. d. k. k. géol. Reichsanstalt. 1867, No. 2, p. 195.
‖ Silliman's Journal,' xliv., p. 224.
¶ Ibid., p. 219. ** Ibid., p. 201.

Rammelsberg, and communicated to the German Geological Society.* A specimen of sand from the island of Santiago, in the Cape Verd group, has been examined by M. Silva, and found to consist of titaniferous iron; as it occurs in considerable quantity it promises to become of commercial importance.† Some new analyses of Norwegian iron ores have been published by Mr. David Forbes.‡

Von Haidinger has laid before the Imperial Academy of Sciences of Vienna, two reports on an extraordinary shower of meteoric stones which fell on the 9th June, 1866, in the neighbourhood of Knyahinya, in the north-east of Hungary.§

The 'South Durham and Cleveland Mercury' speaks of a newly discovered deposit of gypsum, which within the last few months has been very successfully worked by Messrs. Jackson, Brayshay, and Jopling, of Lackenby.

A small pebble picked up some time ago by a little girl at Hopetown, in Cape Colony, and used for a while as a child's plaything, has turned out to be a diamond of the value of 500*l*. Several others have since been found, and the 'Society of Arts Journal,' quoting a Cape paper, says that people are now prospecting in all directions for diamonds in the neighbourhood of Colesberg. Garnets have also been found in the Colony in considerable numbers.

Amber—or at least a resinous substance reputed to be such—must be added to the long list of mineral products already furnished by Australia. It occurs in a large deposit, described as "a mine of amber," at Grass Gulley, near Rokewood, and is said to correspond in all respects with the European mineral.‖

Mining and Metallurgy.

Of practical Metallic Mining we have only to chronicle a continuation of that depression to which we referred in our last number. The consequence of this is the extension of that distress which naturally arises from the want of labour. Happily, the benevolent have taken the serious question in hand, and it is to be hoped that the severities of winter will be ameliorated by their efforts.

The most striking feature in Metalliferous mining has been the anxiety to supplement the labour of the Miner by machinery. At the late meeting of the Royal Cornwall Polytechnic Society, a large number of Boring Machines were exhibited and described, and we now find that some of these are about to be introduced into the

* Zeitschrift, xix. Heft II., p. 400.
† 'Comptes Rendus.' 1867, No. 5, p. 207.
‡ 'Chemical News,' Nov. 23, 1867, p. 259.
§ Sitzungsber. d. k. ak. d. Wiss., Bd. LIV., p. 200 and p. 475.
‖ 'Journ. Soc. Arts,' Sep. 20, Oct. 4, 1867.

mines around Camborne. We shall therefore shortly learn if they fulfil the conditions required for driving levels, or for sinking shafts.

The Reports of the Colliery Inspectors have been published. These tell a melancholy tale of the loss of life in Mining for coal, the numbers being largely increased during last year by the terrific casualties at the Oaks Colliery, in South Yorkshire, and at Talk o' th' Hill, in North Staffordshire.

The returns of deaths are as follows:—

Inspection Districts.	No. of Collieries.	Male Persons Employed.	Separate Fatal Accidents.	Lives Lost.	Tons of Coal raised per Life Lost.
1. Northumberland, North Durham, Cumberland	160	25,647	91	99	108,725
2. South Durham	155	35,720	84	115	129,826
3. North and East Lancashire	265	25,440	58	69	98,173
4. West Lancashire, North Wales	180	30,000	105	150	55,666
5. Yorkshire	434	35,500	61	425	22,235
6. Derbyshire, Nottinghamshire, Leicestershire, Warwickshire	196	27,100	55	58	131,034
7. North Stafford, Cheshire, Shropshire	220	20,210	47	181	30,387
8. South Staffordshire Worcestershire	544	27,000	96	109	94,495
9. Monmouthshire, Gloucester, Somerset, &c.	228	26,000	75	81	74,074
10. South Wales	338	29,200	113	120	78,137
11. East Scotland	254	21,200	29	32	190,625
12. West Scotland	218	20,046	43	45	131,880
Total	3,192	323,063	857	1,484	
And averages	..	..	..	..	67,877 Tons

Total of Lives lost from different causes.

	1865.	1866.
Explosions of Fire Damp	168	651
Falls in Mine	381	361
In Shafts	163	162
Miscellaneous underground	179	203
On Surface	93	107
	984	1,484
Increase of deaths in 1866		500

On the 9th of November a terrible explosion occurred at the Ferndale Colliery, in the Rhondda Vach, Glamorganshire, by which

nearly two hundred lives were sacrificed. This accident, in all probability, arose from some act of gross carelessness on the part of some of the coal hewers, as Safety Lamps were found with their caps off, and it is said keys for opening them have been discovered hidden in the dresses of some of the dead men.

It has been repeatedly stated that colliery explosions have been connected with a sudden depression of the atmospheric column, and this, there can be no doubt, has often been the case. Although it has been so reported with regard to the Ferndale explosion, it is curious to find that really a very high barometer prevailed both before and at the time of the explosion. At Clifton the mercury stood at 30·60 inches; at Bristol at 30·69; and over every part of the British Isles the barometer exhibited that high reading which marks the passage of the great November atmospheric wave.

In connection with mines and quarries, a very important decision has been given by Vice-Chancellor Malins. In a codicil to Lord William Powlett's (the Duke of Cleveland) will it was said, "I bequeath all shares, debentures, or securities, in railways and mines, of which I shall die possessed, to my wife, Lady William Powlett, absolutely." Upon this the question arose whether the bequest included shares in the Welsh Slate Company. It was contended on the part of Lady Wm. Powlett that the quarry had been worked for the last eight years underground, and had therefore become *a mine;* while the opposing party showed that the property was rated as a quarry up to 1866, whereas if it had been considered a mine it would have been exempt from rating. The Vice-Chancellor said that the only thing to distinguish a mine from a quarry was *the mode of working.* This one was worked as a mine; and therefore it would go to the plaintiff.

In Metallurgy there is really nothing of interest to communicate. Every branch of the metal trade suffers severely; and there is but little prospect of any speedy amendment. Yet our spirited Iron-masters, not discouraged, are building blast-furnaces of gigantic proportions, and fitting them with all the appliances of science. The Rosedale and Ferry Hill Company have just completed two blast-furnaces of the height of 105 feet by 28 feet, blown by four powerful blast-engines, and fed by two hydraulic lifts constructed by Sir Wm. Armstrong.

Puddling by Machinery still engages attention. Mr. Thomas Roper, of Ulverstone, has specified a process of manufacturing Iron and Steel, in which a modification of the processes of Nasmyth and Bessemer are involved. High-pressure steam is blown through the iron, in a puddling furnace, to remove the sulphur as sulphuretted hydrogen, and then air to decarbonize the iron. The puddling furnace employed is of a complicated structure, but its principal features, as we understand them, are a circular bed, which holds

the iron to be operated on, and a hollow vertical shaft, capable of being raised or lowered, which is fitted with two or more horizontal arms. This represents the "rabble." These arms dip into the melted metal—the shaft revolves, and, either steam or air being forced down it, passes from the arms through the iron, and, by the combined operation of the steam, air, and motion, puddling is rapidly effected. We shall wait for further experiments before we enlarge on this arrangement.

We regret to have to chronicle the death of Dr. E. H. Birkenhead, F.G.S., lecturer on Science at the Free Library School of Science, and Royal Infirmary School of Medicine, Liverpool, and Master of the Wigan Mining School. He was the ablest of all the Science teachers certificated by the Science and Art Department. His loss is deeply felt in Liverpool and Wigan, and in both towns successful efforts are being made to raise a fund for his widow.

10. PHYSICS.

Light.—Some valuable experiments on solar radiation have been made by M. Soret on the Glacier des Bossons and the summit of Mont Blanc. He finds that the increase of the radiation with the altitude is less rapid than the diminution of the barometric pressure, or than the diminution of the atmospheric thickness. This result is contrary to what can be deduced from the observations made by Professor Forbes in 1832 on the Faulhorn and the Brientz.* The atmospheric pressure being the same, the radiation observed at an elevated altitude is more powerful than at a lower elevation. The ratio of the intensity of the solar radiation on Mont Blanc and Geneva is as about 6 to 5.

Father Secchi has examined the flame of the Bessemer converter, and has observed several points of resemblance between its spectrum and that of certain yellow and red stars. It is well known that the Bessemer flame in the spectroscope when the iron is completely decarbonized, presents a series of very fine and numerous lines, which remind one of α Orionis and α Herculis, only reversed. This results undoubtedly from the great number of metals burning in the flame, and the spectrum presents several lines well known and determined. This flame seems to be the only one comparable with that of the coloured stars, and there is nothing improbable in this when we consider how largely iron predominates in aerolites.

The same artificial spectrum—that of the flame of the Bessemer converter—has likewise been examined by Professor Lielegg. This flame is supposed to be carbonic acid gas in an incandescent

* 'Phil. Trans.,' 1842, part ii., p. 225.

state, and the spectrum of this gas being yet unknown, the observ ations of M. Lielegg have served to fill up a gap in the series of spectra produced by the gases in ignition. The apparition and the disappearance of some of the luminous fixed lines is closely connected with the metallurgical operation. At the moment the decarbonization of the iron is nearly terminated, the spectral lines undergo essential modifications. The apparition of a group of lines and of an isolated line in the violet-blue portion of the spectrum marks a particular reaction, during which the soft iron is being formed, and these lines disappear sooner than all the others; their appearance and disappearance serve therefore to indicate the termination of the process.

The same indefatigable observer has also ascertained that the spectrum of the colour of sea water is deprived of its red portion at small depths, and successively of the yellow and green, for the greater depths, until it appears of a violet-blue. In trying to ascertain whether the same was the case in glaciers, he has made some interesting experiments in an artificial grotto in the Grindenwald glacier. This cavern is 100 mètres deep, transparent in its walls, through which the solar light penetrated. The light was of a fine blue tint, the red being extremely weak, so that in the grotto human countenances assumed a cadaverous aspect. On looking towards the entry, at a certain distance in the cavern, it appeared to be lit up with a red light, doubtless the effect of contrast. The thickness of the superposed mass was not enough to show a greater effect than the almost complete absence of the red, and a great diminution of the yellow. The ice was said to be 15 mètres thick, but was probably less; it was perfectly compact and limpid, but with a few air-bubbles.

M. Felix Lucas concludes from theoretical considerations that the luminous distance at which the electric spark is visible is greater than that of a permanent light, the apparent intensity of which would be 250,000 times that of the spark. The light actually employed to illuminate modern lighthouses gives a brilliancy equal to 125 carcel lamps. An electric spark possessing the illuminating power of the 200th part only of a carcel burner is superior as to its power of projecting light. Hence we can conceive the immense effect of a warning light composed of intermittent flashes of the electric spark proceeding from a strong Leyden battery. M. Lucas states that, in an experiment made in a laboratory two apparatuses were established, one voltaic battery equal to 125 carcel lamps, and another spark-battery equivalent to only the 1-2000th part of a carcel lamp. The photometer (such as is employed in the light-house administration) showed a marked superiority in favour of the spark.

Photographers will read with interest the announcement by M. Prat of the discovery of a compound of silver more sensitive to light than the chloride. This chemist has been for some time past investigating the chemical constitution of fluorine compounds and the isolation of fluorine. M. Prat starts from the fact that the fluorides are really oxyfluorides; that the fluoride of calcium, for example, is formed of two equivalents of calcium, one of oxygen, one of fluorine; and that, in consequence, the true equivalent of fluorine is 29·5, and not 19. In order to obtain fluorine, it is only necessary to treat the fluoride of calcium with chlorate of potassium, or, what is better, perchlorate of potassium, for it is only with this last salt that the reaction takes place. Oxygen is disengaged, and a gas is produced, which silver absorbs, giving rise to a fluoride of silver, insoluble in water, soluble in ammonia, from which it is precipitated by nitric acid, and which is altered by the action of light more rapidly than the chloride of silver; the formula of the real chloride is Ag Fl, whilst that of the soluble fluoride of chemists is Ag Fl, Ag O.

Several new instruments, suitable for the observation of different organs of the eye, have been described by M. Robert Houdin. They serve also for the examination of entoptic images, or the shadows thrown on the retina by intra-ocular bodies. Seven instruments of this class have been invented by M. Houdin; these are: 1, the *Iridoscope*, for the manifestation of entoptic images; 2, the *Diopscope*, by the aid of which the inversion of the images on the retina are determined; 3, the *Pupilloscope*, demonstrating in a magnified form the dilations and contractions of the pupil; 4, the *Pupillometer*, which gives the diameter of the pupil to within a quarter of a millimetre; 5, the *Diopsimeter*, for measuring the extent of the field of vision; 6, an *Optometer*, for the use of any persons who wish to determine the distance of distinct vision; 7, the *Retinoscope*, an instrument with which one can see the vesicular group in his own eye.

In all stereoscopes there is an optical arrangement by which the right eye sees an image of one picture and the left eye that of another. These images ought to be apparently in the same place, and at the distance of most distinct vision. In ordinary stereoscopes these images are vertical; the observer has to place his eyes near two apertures, and he sees the united images, as it were, behind the optical apparatus. Professor J. Clerk Maxwell, F.R.S., has recently had made by Messrs. Elliott, Brothers, a real-image stereoscope, in which the observer stands at a short distance from the apparatus, and looks with both eyes at a large lens, the image appearing as a real object close to the lens. The stereoscope consists of a board about two feet long, on which is placed:—1, a vertical frame, to

hold the pair of pictures, which may be an ordinary stereoscopic slide turned upside-down; 2, a sliding piece near the middle of the board, containing two lenses of six feet focus, placed side by side, with their centres about one inch and a quarter apart; 3, a frame, containing a large lens of about eight inches focal length, and three inches diameter. The observer stands with his eyes about two feet from the large lens. With his right eye he sees the real image of the left-hand picture formed by the left-hand lens in the air close to the large lens, and with the left eye he sees the real image of the other picture formed by the other lens in the same place. The united images look like a real object in the air, close to the larger lens. This image may be magnified or diminished at pleasure, by sliding the piece containing the two lenses nearer to or farther from the picture.

Heat.—Herr C. Sching has investigated the subject of fusible silicates, and the temperature required for forming and melting the same. He finds by application of a thermo-electric pyrometer that silicates are formed and melted at the same temperature, and that the formation of the silicates depends more on time than on temperature, *i. e.* it depends, in fact, on the conducting power of heat which the materials composing the silicates possess. He also finds the temperature required for melting metals and metallurgical products to be lower than usually stated, 1,431—1,445°, for melting the same. Sching now finds that a temperature of a glass furnace in operation is only 1,100—1,250° C.; that crystal glass is worked at 833°, and becomes completely liquid at 929°. A Bohemian green glass tube softens at 769°, and becomes liquid at 1,052°. Pure limestone loses its carbonic acid by heating for several hours at a temperature of 617—675°. An increase of the temperature will shorten the time.

Mr. C. Tomlinson, F.R.S., in a communication to the 'Chemical News,' has stated his opinion that the Camphor Storm-Glass is useless as a meteorological instrument. The frequent reference made to it by the late Admiral Fitzroy gave an almost official sanction to its use, and induced some instrument makers to manufacture it largely, and even to attach it to the ordinary barometer and thermometer. This led Mr. Tomlinson to examine the storm-glass with some care. One was made on a large scale in a quart bottle, placed on the window ledge, and a journal of its behaviour kept during some months. The conclusion arrived at was that the storm-glass is not acted on by light, or atmospheric electricity, or wind, or rain, &c., but solely by variations in temperature; that it is, in fact, a rude kind of thermoscope, vastly inferior to an ordinary thermometer, and has no meteorological value whatever.

The subject of the transparency of red- or white-hot metals was referred to in our last Chronicles. It is generally believed amongst scientific men that the supposed phenomenon is merely an optical delusion. A correspondent of the 'Chemical News' has, however, adduced an observation on the opposite side. He says a few weeks ago he went over some steel works in the North of England, and there the manager spoke of it as a well-known fact that steel at a white heat was transparent. In proof of this he showed that when the molten metal was being poured out, the edge of the crucible appeared to be distinctly visible through the molten metal. This could only be seen directly the crucible was taken out of the furnace before it had cooled in the least.

Mr. A. E. Fletcher, Government Inspector of Alkali Works for the Western District, has constructed a most useful instrument for measuring the velocity of a current of air. He uses it for measuring the speed of air in flues and chimneys. The construction of the apparatus is based on the fact that a current of air, passing across the open end of a straight tube, causes a partial vacuum in it. An application of this principle is seen in a small toy in common use, in which a liquid is made to ascend several inches in a vertical tube, by blowing through another tube across its open end; it rises by virtue of the partial vacuum caused by the current of air which crosses it. If then a straight tube is inserted through a hole in the brickwork of a chimney or flue, so that the current of air in the flue passes across its open end, a partial vacuum will be formed in it, greater or less in proportion to the velocity of the current. A tube in such a position will, however, communicate a suction arising from that of the chimney itself, besides that suction produced by the current of air passing across its open end, and for the present purpose these two must be distinguished. To effect this, *two* tubes should be inserted in the chimney, one of them having a straight, and the other a bent end, the bend to be turned so as to meet the current of air; both tubes are open. In each of these tubes will be experienced the partial vacuum due to the suction of the chimney itself. In the straight tube, however, this will be increased by the suction caused by the passage of the current of air across its open end, while in the case of the bent tube this will be diminished by the pressure caused by the current of air blowing into it. The difference therefore between the suction in the two tubes will be due to the action of the current of air in the chimney, and it remains only to measure this difference in order to measure the velocity of the current itself. After many trials, Mr. Fletcher adopted the following plan for measuring this suction. The tubes were connected with a U-Tube, and means were adopted for accurately seeing and measuring its slightest indications. In the first place, the limits were increased until they were no longer small tubes of

about 0·4 inch internal diameter, but cylinders of 4 inches diameter; these were connected at the bottom by a small tube. Thus the power, exerted by the pressure communicated through the connecting tubes, operating on the extended surface of the liquid in the cylinders, was increased a hundred-fold over that operating in the smaller U-Tube; but the friction could only have been increased ten-fold, giving therefore a ten-fold increase of delicacy. In order to observe accurately the rise and fall of the liquid in the cylinders, floats were introduced, on each of which was engraved a very fine horizontal line; and to measure accurately the comparative elevation or depression of these two lines, a finely divided scale and vernier were added, working with a delicate screw adjustment. With this it is possible to measure an elevation or depression of $\frac{1}{10000}$th inch, which is sufficiently accurate for the purpose in view.

On trying now to apply the instrument so constructed, and attempting to measure very minute variations of pressure, failure still seemed imminent; for although the motion of the water in the increased limbs of the U-tube could be measured to $\frac{1}{10000}$th inch, the water refused to move except under pressures exceeding that which would be indicated by so small a column: in other words, the water seemed to stick in the cylinders. After substituting ether for water the action of the manometer was quite satisfactory; the lines on the floats always returned exactly to their original position after any disturbance, and its indications could be relied on to $\frac{1}{10000}$th inch.

By the aid of this ether manometer the speed of any current of air in flues or chimneys can be measured by simply boring a hole one inch in diameter through the brickwork, and inserting two tubes, one with a bent, the other with a plain end as already described, and making the necessary observation of the floats; and in this operation neither soot, heat, nor corrosive vapours can prove any hindrance.

So sensitive is the apparatus, that on a windy day the effect of each successive gust of wind is observable, as it causes variations in the draught of the chimney. The instrument may be used as a wind gauge, by fixing through the roof of an observatory a small vertical pipe presenting a plain open end to the wind. The lower end of this pipe brought down into the observatory and connected with the ether manometer, would communicate the varying pressures due to the varying speed of the wind.

Electricity.—M. Rondel has examined a phenomenon which has been noticed more than once by workers with induction coils. If while the current of a pile passes through the primary wire of a coil, one of the extremities of the secondary wire is brought near one of the extremities of the iron core, sparks can be drawn of

remarkable intensity and brilliancy; if at the same time, the other end of the secondary wire is put in communication with one of the poles of the pile, a great increase takes place in the brilliancy of the spark. Then, on touching with the hand the iron core, and placing the free end of the wire in contact with the skin, a redness takes place, and a smart stinging sensation is felt. This last experiment was made upon a coil, the core of which, completely isolated in a tube of varnished glass, was eight millimètres in diameter. M. Rondel made the same experiment with another bobbin, the soft iron of which was twelve centimètres long, five centimètres wide, and eight millimètres thick. The sparks were produced with detonations. A single Bunsen element of small size was sufficient to produce these phenomena.

A note on the Polarization of Electrodes—a subject of considerable interest to telegraphists and electricians—has been presented by M. Gaugain to the Academy of Sciences. Several savants have sought to determine the part which each of the electrodes takes in the polarization, and have arrived at different results: M. Poggendorff found that the two electrodes contributed equally to the production of the electromotive force developed; MM. Lenz and Sarvelgen found, on the contrary, that the part of the cathode is greater than that of the anode. M. Gaugain has tried, in his turn, to resolve the question by making use, as he did on former occasions, of the *method of opposition*. The following are the results thus obtained by a series of experiments carried on with a mixture of nine parts by volume, of distilled water, and one part of sulphuric acid:—

Polarization of the anode	193
„ of the cathode	157
Total polarization	350

It appears to be of little consequence, if more or less sulphuric acid be added to the electrolyzed water, provided that this proportion does not fall below a certain limit; but when it becomes extremely small, the polarization of the cathode increases, without the polarization of the anode being sensibly modified. The following are the results obtained by electrolyzing pure water:—

Polarization of the anode	193
„ of the cathode	243
Total polarization	436

M. Matteucci recently* called the attention of the Academy to an experiment which he made in 1838, and upon which he

* 'Comptes Rendus', Jan. 14, 1867.

depended to prove that the polarization proceeded from the gases adherent to the electrodes. In fact, polarized metals should be considered as fugitive combinations formed by the metals and gases, and the author is of opinion that in polarization couples as well as in Grove's gas pile the electro-motive force is the affinity exerted on one of the elements of the water by a gas associated in a particular manner with a metal.

Dr. Henry Morton, of the University of Penna, Philadelphia, has lately described an important adjunct to the induction coil. He prepares the arrangement in the following manner:—Take eight plates of glass, about 11 inches by 14 inches, and attach to both sides of each plate, sheets of tinfoil, 7 inches by 10 inches in size, with rounded corners. Set these plates upright in a box (provided with grooves for the purpose) about $1\frac{1}{2}$ inches apart; then rolling up some balls of paper large enough to fit between the plates, and wrapping a strip of tinfoil around each ball, thrust them between the plates, and, lastly, make an outside pole to the terminal sheets of foil, by means of wires enclosed in glass tubes passed through the side or top of the box. It is evident that we have here a compact form of Leyden battery, arranged for "cascade." With the ordinary electrical machine such an arrangement would be worthless, from its want of insulation. With the induction coil, however, which developes an entire charge in an instant, it becomes of great value in a certain class of experiments, because it gives us at once the concentrated charge peculiar to the Leyden battery, combined with a spark length, which it would otherwise have lost. (This property of long spark in the "cascade" arrangement of jars is well known.) If such an apparatus as here described be connected with the secondary poles of an induction coil, and other wires are then led off (with a break in the circuit, however, of $\frac{1}{4}$ to $\frac{3}{4}$ inches) to some piece of apparatus for the illustration of electric discharge in vacuo, such as Gassiot's cascade (especially with a canary goblet), the aurora tube, an electric egg of canary glass, &c. (but not a Giessler tube), the brightness of the illumination and volume of the discharge will be immensely increased. Thus a goblet invisible at 30 feet, when the unaided coil is used, becomes *brilliant* at 50 feet with this attachment. The author has used two coils with the above apparatus, both made by Mr. E. S. Ritchie, of Boston, one yielding a spark of 8 inches, the other, which gives, in its present mounting, sparks of 16 inches, to provide against accident; such a length being abundantly sufficient for use. Geissler tubes, unless of very large area, are not benefited in appearance by this arrangement, because the unaided coil can supply all the electricity they are capable of transmitting, and this excessive charge only tends to develop inductive resistances in the glass tubes themselves, which resistances this *momentary* current is the least fitted to overcome.

The author mentions another little practical detail in this connection. It is generally assumed that the induction-coil is unfit for the exhibition of those experiments of attraction and repulsion which especially characterize statical electricity. A great number, however, may be very satisfactorily exhibited by charging Leyden jars, and using them as the sources of electricity. Thus:—Connect a chime of bells with the knob of a large jar; connect the outer coating with the earth and with the negative pole of the coil; then bring the positive pole within striking distance of the knob, and charge by a few sparks. The electrical flyer, orrery, sportsmen, and birds may be successfully operated in this way, even in summer weather. The coil should not be of less than six inches spark length.

M. J. E. Balsamo has presented a memoir to the Academy of Sciences on a new Voltaic Pile. It is formed of two plates of iron, one plunged in dilute sulphuric acid, the other in a solution of chloride of sodium, separated from the acidulated water by a porous diaphragm. The iron of the acidulated water acts as zinc, and that of the saline solution acts as copper. The current, constant and of considerable intensity, proceeds from the property possessed by iron of polarizing itself differently in certain solutions, between which osmogenic action takes place. M. Balsamo has also tried another experiment of considerable theoretical interest. He plunges at the same time in oxalic acid two small magnetized bars of the same surface and of the same weight, one having its north pole in the liquid and its south pole out of it. The second bar is in the contrary position. The first acted as zinc, the latter as copper, and a current of electricity was the consequence.

M. Becquerel, sen., has continued his electro-capillary researches to which we drew attention in our last Chronicles. He shows definitely that—1. The alteration is exerted on the sides of the capillary spaces between two liquids. 2. The electricity is disengaged at the contact of these liquids in the capillary spaces. He has modified his method of experimenting. Instead of forming the fissures in the tubes, he fastens at their extremity a strong stopper very tightly fixed, made with filtering paper soaked in water; a platinum wire traverses the stopper and connects the two liquids together.

M. Bouchotte has examined the electrolytic power of the currents of the magneto-electric machine made by the Alliance Company. When the current sent by the commutator is always in the same direction, the electro-motive power is that of 144 Daniel elements with sulphate of copper; but when the current is alternate, as in the production of the electric light, the electro motive power is *nil*.

10. ZOOLOGY—ANIMAL PHYSIOLOGY AND MORPHOLOGY.

Physiology.

Work and Food.—A new phase of this question has been brought about by the very valuable experiments of Dr. Parkes (of the Military Hospital and Medical School at Netley) on the Elimination of Nitrogen during rest, an account of which he has communicated to the Royal Society. We have in a previous Chronicle noticed the views and experiments of Fick, Wislicenus, Frankland, and the first series of Dr. Parkes' researches.* Dr. Parkes has found that during a period of work a man excretes less nitrogen than during a period of rest—whether he feeds on nitrogenous food or carbonaceous only. He also finds that after nitrogenous food has been cut off from the system and again supplied, there is a retention of that nitrogen showing that it is needed to fill up some waste; also, that during the first rest after exercise, where nitrogenous food had not been cut off, there was an increase in the elimination of nitrogen. The experiments on which these statements are founded may be thoroughly trusted, and lead to important considerations, Dr. Parkes having experimented on two soldiers, and having every means of analysis at hand. It will be seen that they place the question in quite a new aspect, and no theory of the relation of food, muscle, and work can be now tenable which does not account for them. Dr. Parkes' view is, that when a voluntary muscle is brought into action by the influence of the will, it *appropriates* nitrogenous matter and grows; the stimulus on the act of union gives rise to changes in the non-nitrogenous substances surrounding the ultimate elements of the muscular substance, which cause the conversion of heat into motion. The contraction continues until the effete products of these changes arrest it (as they have been shown to do by Ranke and others), a state of rest ensues, during which time the effete products are removed, the muscle loses nitrogen, and can again be called into action by its stimulus. Dr. Parkes does not believe in the efficiency of carbonaceous foods when alone, which recent experiments might seem to indicate. Fick and Wislicenus, he says, drew upon the store of nitrogenous matter in their *system* when they cut it off in their *food*, and he maintains that carbon foods can only be efficient in the presence of nitrogenous matter also. When a muscle loses nitrogen, fat is probably formed, and thus a muscle, disintegrating during the period of rest, may form a store of fat in its texture, which may become efficient at the next addition of nitrogenous matter as a source of force. The argument as to the *oxidation* of nitrogenous matter being insufficient to account for work is true enough, but

* See also Dr. Hinton's paper in the July number.

oxidation is not the only chemical change taking place in the blood, as Berthelot has shown; the appropriation of albumen-nitrogen, and its change into muscle-nitrogen, may, and probably does initiate the other chemical changes in which carbonaceous foods become efficient as sources of force. Dr. Parkes' view is very satisfactory, as striking the mean between the old and new views; it harmonizes with the teaching of experience, and restores to the rules of diet their old significance. One thing is to be regretted in all experiments upon this subject made with human beings: in them the evolution of cerebral force is as variable as that of muscular force, and cannot be regulated or taken into account. It must—equally with muscle-work—modify the elimination of nitrogenous matter and carbonic acid, and yet there appears to be no means of guarding against it as a source of error. The brain *may be more active* during the period of muscular rest than during muscular exertion.

Animal Mechanics.—The Rev. Samuel Haughton, of Trinity College, Dublin, has offered some experimental proofs of two elementary principles in animal mechanics:—first, that the force of a muscle is proportional to the area of its cross-section; and, second, that the force of a muscle is proportional to the cross-section of the tendon that conveys its influence to a distant point. Dr. Haughton concludes that the contractile force of muscle is ordinarily 109·4 lbs. to the square inch of cross-section. He compares his results with those of Donders, of Utrecht, made on the Biceps and Brachiæuss, whilst he has observed most of the large muscles of the leg and arm. A most ingenious and noteworthy method of estimating the cross-section of the muscle in square inches was made use of. A piece of card was cut exactly of the shape and size of the area of the divided muscle, and this was then carefully weighed in a balance against square inches and fractions of square inches of the same sort of cardboard; thus by means of weighing, the most complicated calculations of area were avoided.

Blood.—Preyer believes that cruorine (hæmoglobin) is an acid. When frozen *in vacuo* with a solution of carbonate of soda, the carbonic acid is given off and a cruorate of soda formed, retaining the peculiar absorption spectrum of cruorine. Alkaline sulphides have been shown by Nawrocki and Preyer to first reduce cruorine, and then give a new pair of absorption bands indicating a distinct and stable combination. German observers, and Dr. Arthur Gamgee in Britain, seem very hard at work with the spectroscope, examining various reactions of blood colouring matter. The first number of the new volume of the 'Journal of Anatomy and Physiology' contains a very excellent summary of, and reference to, these researches. Dr. Thudichum's observations with the spectroscope on the fluids of cholera patients (published with illustrations in the Privy Council Report) are interesting in this connection.

Salamander Poison.—Dr. Zalesky has found an alkaloidal active principle in the poisonous secretion of the spotted salamander. He calls it Salamandrine, and remarks that it has much the same effect on animals as strychnia; but the spasms produced by the former are clonic, whereas by the latter they are tonic.

The action of Antiseptic Agents.—Some time since we drew attention to experiments on this subject made by Mr. Chapman, of Oxford. Dr. Binz, of Bonn, has been investigating the effects of antiseptics on animalcules found in vegetable infusions, and has obtained some satisfactory results. The antiseptic was allowed to come into contact with the animalculæ (Colpoda), while in the field of the microscope. Binz distinguishes two destructive actions, an osmotic one, causing the creature to burst, as with chloride and hyposulphite of sodium, chlorate of potassium and alum; and a directly poisonous action observed with nitric, sulphuric, tannic, and acetic acids, creosote, permanganate, corrosive sublimate, iodine, bromine, chlorine, and quinia. Acetic was the powerful acid poison. Quinia had a very powerful effect, but salicine was not found to exert any influence, nor nitrate of strychnia, in the course of two hours.

Digestion by the Pancreas.—Dr. Kühne, of Berlin, Virchow's assistant, in his physiological laboratory, has obtained some interesting results in this matter. He took the pancreas of a large dog, and having washed it, immediately placed it with a quantity of fibrin in hot water to digest. The whole of the fibrin was in six hours dissolved into a pepton, which was further almost entirely converted into tyrosin and leucin. It was found that alkaline pancreatic infusion will not only digest proteids, but will digest them at a rate and to an extent compared with which gastric digestion seems a slow and feeble process. It takes the collected ferment of a whole stomach days to digest half the amount of fibrin which the pancreas will digest in as many hours. The pepton produced, differs in no essential respect from gastric pepton. The interesting thing is the enormous production of tyrosin and leucin, at the expense of the pepton. For, if the process was delayed, Kühne found that a much larger proportion of pepton was produced. In the body the pepton diffuses away as fast as made, and hence no excess of tyrosin or leucin can be formed. It would be a satisfactory thing if Kühne could try his experiment again, making use of a dialytic medium. An ordinary dead animal membrane could not be used as it would itself be digested.

Morphology.

The fibres in the muscular wall of the stomach are stated by Dr. J. B. Pettigrew to resemble in man and other mammalia that which he has already described in the heart and bladder. The

most external and internal fibres are more or less longitudinal, and the deeper or more central fibres become more and more oblique as the centre of the parietes is reached. The longitudinal intersect the very oblique at nearly right angles; the slightly oblique and oblique at more acute angles. Dr. Pettigrew considers that there are indications of seven layers of fibres, three external, three internal, and one intermediate; but he uses the term layer in a more restricted sense than in his former papers on the heart and bladder, and now admits that there is a mutual interchange of fibres between the different layers.

Minute Structure of the Liver.—New views with regard to this matter have lately come before the world, and seem to be very generally accepted by the leading histologists. Hering, Eberth, and other foreign observers, have renounced Dr. Beale's view, as also that which attributes to the bile-ducts the formation of distinct capillaries within the lobules, having a membrana propria like the blood capillaries, and in contact only externally with the liver-cells. Professor Turner supports the new view, which is, that the bile passes to the periphery of the lobule in channels, which lie between and have their walls formed by the liver-cells, and which communicate with the interlobular branches of the hepatic duct. Preparations of rabbit's liver, in which the bile-ducts have been injected immediately after the death of the animal, are the data which have lead to this new conception. Professor Hering has also studied the lives of many other mammals and reptiles.

The Gall-Bladder.—The gall-bag is a most strangely variable organ. Dr. Macalister states that it is constantly present in bimana, quadrumana, cheiroptera, insectivora, carnivora, marsupialia, monotremata; absent from cetacea; variable in edentata, pachydermata, rodentia, and ruminantia. As a rule it is present in birds and reptiles, and almost universally in fish. An explanation of its variability (varying sometimes even in the same species) is that it is required in those animals whose intervals of feeding are protracted, and is of little use in those in which the bile flows continuously from the liver, to aid in the almost constant process of digestion.

The Axolotl and its Gill-tufts.—It has been long thought that the Mexican perennibranchiate Salamander might prove to be merely a larval form, and develop into a true Salamandroid. Moreover, the presence or absence of gills or their apertures in the adult state has been found to be merely a question of degree, and not of much taxonomical value. Van der Hoeven pointed out that the giant proteid of Japan could not be separated from the American Menopoma, though in the first the gill apertures are lost in adult life, and in the second they are persistent. From the experiments of M. Auguste Duméril on the Axolotls now alive and breeding in the ménagerie at Paris, it appears that in this creature the per-

sistence of the gills is purely accidental: they are of no functional importance, and may be cut off without injuring the animal. When cut, they grow again, and may be again cut. Persistence in cutting the gills causes the Axolotl at length to undergo certain changes in colour and appearance, and to approach more closely to the fully-developed Salamandroid. It is a remarkable thing that even whilst these gills, evidently the mere relics of larval structure, are attached to the Axolotl, it becomes sexually mature, and breeds (as it has done at Paris). M. Duméril appears to show that sometimes an Axolotl may lose its gills at an early period of life—in other cases, perhaps not at all—and there is great variability in the time when the supply of blood to these parts is cut off, and an absorptive process commenced. Perhaps the diminution of accessible nutriment might have some effect in causing an earlier absorption of the appendages. The most important of M. Duméril's observations—zoologically—is the discovery that the Axolotl does spontaneously lose its gill-tufts and tail crest, and becomes a true Salamandroid—approaching certain North American forms. In fact, M. Duméril says the Axolotls are only the tadpoles of the *Amblystomi*, and, most strange to say, have the power of sexual reproduction as tadpoles. Does not this open up a case for the students of natural selection? The tadpole of a northerly Batrachian, when placed in a tropical clime, tends to retain its tadpole form, and to acquire sexual maturity in that condition (or *vice versâ*). But there are almost the same remarkable facts with regard to our own common newt.

Amphioxus and Nerve Termination.—M. P. Bert has some remarks on this lowest of vertebrates in the 'Comptes Rendus.' It has been taken this year for the first time on the oceanic shores of France, though many specimens have been observed on the English south coast. M. Bert corrects some of the errors made by M. de Quatrefages. He denies the existence of the lateral canal opening at the side of the mouth, and describes the position of the abdominal pore and its relation to the body cavity. Like all other fish, Amphioxus has the generative glands early developed, and it has been strangely asserted by Agassiz that it is an immature form. M. Bert has seen it spontaneously discharge the spermatic fluid, which proves the assertion to be baseless. He also speaks of the termination of the nerves in corpuscular bodies. This gives us an opportunity to refer to a paper on the same termination of nerves in various animals published in M. Robin's Journal. In these, also, corpuscular terminations are described closely connected with muscle fibres. M. Bert very properly maintains that in *Amphioxus* there is a retiform or endless disposition of the finer nerve twigs as well as these corpuscles. No doubt the reconciliation between the views of Dr. Beale and of his opponents (who are now becoming very few in number) will be found in admitting fully both methods of ter-

mination. It seems not at all improbable that the corpuscular bodies in connection with nerve-ending and muscle fibre may be connected with sensation—that form of it, which is called the muscular sense, just as other corpuscular bodies (tactile, &c.) are connected with the more obvious perception of heat, cold, and other vibrations. "Plaques motrices" will have to be abandoned as such, and regarded merely as corpuscles of muscular sense.

Development of Cuttle Fish.—The distinguished Russian observer Mecznikow has been studying the development of Sepiola—a little Cephalopod common at Naples. He is led to deny some statements of Kölliker, and shows that the development proceeds from two layers. The skin and sense organs are developed as in Vertebrata, and what is most remarkable, a relationship between the Vertebrate's notochord and the so-called "cuttle-bone" is maintained. M. Mecznikow rejects all analogy between the foot of ordinary mollusks and the siphon, as advocated by Huxley. He is equally adverse to the hypothesis of Häckel (a natural philosopher of the Darwinian school) that the Pteropoda are the immediate ancestors of the Cephalopoda.

Insect Architecture.—A curious example of the weaving powers of insects is recorded by Mr. Tomes, of Christ Church, Oxford, in a recent number of the 'Microscopical Journal.' Mr. Tomes found in ponds on Hampstead Heath small cases made of green conferva and an animal basis; the fibres of conferva were very regularly and neatly interwoven, forming a tube open at each end. In this an insect-larva was found, which is minutely described and figured with its case in a coloured plate. Mr. Tomes considers that the larva belongs to the Trichopterous genus *Hydroptila*. He describes the habits of the animal and its method of building the case it inhabits. The perfect insect is not known to Mr. Tomes.

Structure and Differences of Egg-shells.—Dr. Blasius undertook the microscopic examination of birds'-eggs, in order to ascertain whether they presented any characters which would serve to separate the larger groups of birds. An account of his researches, which have been most extensive and detailed, appears in 'Kölliker's Zeitschrift,' 3rd part. It appears that the microscopic differences are not constant or reliable, and that oology must stand just where it did as regards systematic ornithology, even after such careful observations as those of Dr. Blasius.

THE PUBLIC HEALTH.

If any one wishes for a demonstration of the need of change in the Municipal Management of London, he should visit the Metropolis just after a snow storm. Such a storm visited London on the night of the 8th of December, 1867. The next morning, although hundreds of poor men were begging in the streets, being thrown out of work by the snow, there was no effort made to clear the streets and pavements of that snow; and the consequence was that, snow being trampled by the feet of men and horses into ice, numerous accidents to men and horses occurred. That the streets are allowed to remain in this disgraceful state does not arise from want of legal power to put them in a safe condition, but from an entire neglect of duty. Thus the police have the power to fine every person forty shillings who does not cleanse the footway in front of his house before a given time after a fall of snow; but they seldom or ever exercise this power. The greatest sinners in this respect are the government offices and the authorities who preside over our public parks. The footway around these parks is never swept. The vestries try to clean the streets, but their surveyors never have organizing skill enough to get the poor unemployed men together to do this necessary work. If the snow cannot be got away, an immense saving of horse flesh and horse pain would be effected by throwing gravel or sand down the principal thoroughfares. But the vestries will not see what they have to do with protecting strangers' horses passing through their thoroughfares. The *loss* by the payment for gravel and labour would appear against them in the rate book, and as the *saving* of life would not appear, they will have nothing to do with it. We should not have referred so much in detail to this London grievance if it were not that it illustrates a principle. London is badly managed because it is split up into forty Vestries, no two of which will act in concert, and none of them will do anything for the public good. Above all things we want in London *public-spirited* men, men who will sacrifice their own private interests and that of their parishes for the public good. It is too much to expect that the forty or fifty little parliaments by which the Metropolis is governed, with their two or three thousand members should ever produce a majority of public-spirited men. The present system is the worst possible that could be devised for securing the public good. What we really want is that the Metropolis should be governed as a whole, and that it should not be split up into forty or fifty parishes, each having its own narrow-minded

parliament, bent on opposing every advantage to its neighbours, on the ground that it would injure itself. It is to break up this system that Mr. J. S. Mill brought forward a measure for the Reform of the Municipal Government of the Metropolis. It is not necessary that we should here enter into any details of this measure. We must regard it as a means to an end. The concentration of authority which he proposes in this bill, and the administrative power which it gives to bodies having larger powers and wider administrative districts than at present exist in London, would undoubtedly be the means of effecting an immense amount of benefit. This excellent measure has been opposed by nearly every vestry in London. The great excuse for opposition has been that it would increase the *expense* of the Local Government of the Metropolis. This is regarded as a sufficient ground for opposition to any measure. The cry of expense is raised against any measure, whatever may be its promise of prospective gain. The fact is, that when a thoroughly careful examination is made of Mr. Mill's bill, it will be found that a great economy will be ultimately effected. Instead of the multitude of officers with small salaries, which are now the burdens of London parishes, a few effective officers with larger salaries will be appointed. For instance, instead of a large number of medical officers of health, half of whom are confessedly paid for doing nothing, there would be five or six men appointed, who would attend to their duties, and not be allowed to hold sinecures, as is at present the case. In the interests of public health we advocate this measure. As an instance of how the present vestries treat their medical officers, we may give a report of what occurred in the Vestry of St. James's, Westminster, on the 5th of December last, when the medical officer of health, calling attention to the deaths from typhoid fever among the wealthy inhabitants of that parish, said, "Several cases have come under my notice where life has been lost amongst this class. No one should take a house without a certificate of the drains being properly laid; and bricklayers and builders, neglecting their duties in this respect, should be liable to prosecution and fine." The very idea of a man being prosecuted for killing his neighbours in this way was ridiculed; and the report in the 'Marylebone Mercury' of the 7th of December, says "The reading of this passage was received with cries of 'Oh, and laughter.'" There can be no question that in order that the duties of the medical officer of health should be carried out efficiently, his appointment should be independent of such bodies as the present vestries of London. No effectual sanitary measures can be carried out in many districts of London till the medical officer of health is made independent of the influence which the vestry is now capable of exercising over him.

The question of the position and duties of the Medical Officer of

Health is every day assuming more importance. This subject has attracted the attention of Dr. Letheby, the able and energetic Officer of Health to the City of London, and in a paper contributed by him to the 'Medical Press and Circular,' he has given his views. He insists on the necessity of every district in the country being under the supervision of such an Officer. He points out the danger of conferring this office on medical men engaged in private practice, leading, as it often does, to a confliction of interests most unfavourable to the public health. He advocates a wide extension of the duties of the Officer of Health. To him should be referred the Certificates of Death, and he should be entitled to call for the investigation of the Coroner's Court in cases of suspicion and doubt. He should be also appointed assessor in the Coroner's Court, and to him might be committed the necessary inquiries into the cause of death. These inquiries in the Coroner's Court are often of the most slovenly kind, arising from the want of requisite skill on the part of the medical witnesses, now almost entirely depended on by the Coroner in his inquiries. Dr. Letheby's paper is well worth the consideration of all sanitary reformers.

At the meeting of the British Medical Association, held at Dublin, Dr. Rumsey read a paper on 'State Medicine in Great Britain and Ireland,' which, on account of the reputation of the author as one of the ablest writers on State Medicine in this country, demands attention. This paper has now been published separately.* It embraces an account of our registration system, our medico-legal institutions, and our Sanitary laws. Under these heads, Dr. Rumsey points out various defects, and suggests improvements. It is especially to the Sanitary parts of Dr. Rumsey's paper that we would call attention. No one can have watched the efforts that have been made by the English legislature in the interests of public health without feeling that they have proceeded on no principle, have effected but little good, and that our Sanitary laws are at the present moment a worthless piece of patchwork. For want of anything like power to deal with sanitary evils, nuisances of the most injurious and gigantic kind exist in all our large towns, whilst in our country districts, where typhus, typhoid, and scrofula carry off their tens of thousands annually, not even a show of legislature is even made to ward off those evils. With regard to the appointment of Medical Officers of Health alone, Dr. Rumsey points out the utter destitution of anything like principle in their appointment. There are no fixed districts, no duties laid down, no qualifications required. Even in London, where the Metropolitan Act requires that Medical Officers of Health should be appointed: there is no law pointing out their numbers, their salary, or their duties. The consequence

* Ridgway, Piccadilly, 1868.

is, that in half the parishes of London the post is a sinecure, and in the other half the Officers of Health are insulted and persecuted, if they dare to perform duties which they themselves think are connected with their office. Several of these gentlemen have conscientiously thrown up their offices rather than be paid for *not* doing what they felt they ought to do.

Dr. Rumsey advocates the division of the Country into Registration Districts upon the plan of Dr. Farr, and to each of these districts appointing a *specially* educated State Physician. He points out the utter impossibility of educating every medical man in the kingdom in such a way as to perform the duties of a State Physician. He would give the appointment of this officer to local bodies. He thinks that nothing is so likely "to damp or even extinguish local research and local action," so much as continual Government interference. "The public medical officer," he says, "of each extensive district closely observing, verifying, collecting, and revising his facts, making his examinations and reports, directing his subalterns, inspecting public institutions, and advising the magistrates and the executive bodies within his sphere, would give a true value and force to local action which it has never yet attained: would elicit facts, and establish conclusions from local physical conditions and phenomena which might remain for ever unnoticed under mere central action."

If anything were wanted to show how imperfectly the best appointed Central Boards may act, it would be seen in the almost entire failure of the Poor Law Board to fulfil them. Here we have a great department of Government appointed on purpose to overlook the actions of Boards of Guardians and superintend the Workhouse officers, and yet under their very noses in London, a system of abominations was practised in Workhouses, that have led to a complete revision of the whole system. It now appears that the same cruel treatment of the poor, the sick, and the aged, has been going on in our Country Workhouses. It seems to be of no use to appoint new Inspectors. These gentlemen, as soon as Government pay crosses their palms, assume a new position. They turn round upon their old philanthropic brethren, and submitting to the power of red tape, call dirt and neglect, economy, and disease and death, the necessary lot of the poor. The English public, those at least who have heart enough to care for the sorrows and sufferings of the less opulent amongst us, are deeply indebted to the members of the medical profession, and the editors of medical journals, who have been instituting inquiries into the working of some of our Country Workhouses. The result of their inquiries has been to expose in the country a worse system of neglect than existed even in London. We need not go into the details of the result of these inquiries. They have been given in the

Daily Newspapers. We wish, however, to suggest two practical measures. The first is the improvement of the class of persons from whom the masters and matrons of workhouses are selected. It is quite impossible that the class of people who are now generally selected should ever superintend efficiently the large establishments over which they preside. As a rule, they are ignorant and conceited, and often avaricious and dissolute. They in fact spring from the very class whom they have now to rule, and the men win their positions not by any special adaptation for their office, but frequently by failure in business, by success as soldiers or policemen, and their wives are appointed matrons without any reference to their qualifications at all.

It is the constant practice to contrast our jails, where we keep our criminals, with our workhouses, where we keep our honest poor. The jail is a perfect institute as compared with a workhouse. In the one all is order, cleanliness, and care for the welfare of the inmates. In the other the rule is the opposite of all this. Now how do they manage in jails about masters? Why by appointing a gentleman, a man of education, and a man who knows what he has to do in ordering and directing those who are classed under his control. We wonder what would happen to some of our country jails if the master of the country workhouse were appointed to its control. Yet the management of a workhouse requires more knowledge of human nature, a greater power of adaptation of circumstances to changing conditions, than any demanded of the master of a jail. So much is this the case, that we question whether it would not be a wiser plan to appoint at once as master in our workhouses a medical man, who should combine the qualities of master and medical superintendent. Such appointments are always made in Lunatic Asylums, which perhaps in their requirements more nearly resemble workhouses than prisons.

A second suggestion, that we would make as an improvement in our present workhouse system, is the introduction of the Coroner's Court to inquire into the causes of death. The revelations which first excited public attention with regard to the workhouses of London, were the inquiries before the Coroner, in the cases of the deaths of Daly and Gibson. It is very clear that some of the iniquities at Farnham would have been prevented had the Coroner's Court been summoned. At that place a girl was actually scalded to death by carelessness, and no Coroner summoned to inquire. In the workhouse the Master has power, under present circumstances, to send for the Coroner or not. The medical officer is under his control, and for him to refuse a certificate is to bring upon himself punishment or dismissal. One of the most humiliating positions for the medical profession, is the absolute power which Boards of Guardians and Masters of Workhouses have over them. The law

ought not to leave to accident the discovery of the crimes of public servants. In prisons, a Coroner's Jury is summoned on the death of every prisioner, and neither Masters of Prisons nor Country Magistrates can prevent this public inquiry. In county lunatic asylums notice of the death of every patient is obliged to be sent to the Coroner. Can it be doubted that the presence of the Coroner and his jury in these places is the cause of preventing much abuse? If it could be doubted, the comparison of the abuses in our workhouses with our prisons would set the matter at rest.

The practical difficulty of holding so many inquests as would be required in workhouses has been suggested, but this is really imaginary. It is usual in workhouses for the dead to be buried in one or two days in the week, and it would be very practicable for the Coroner's Jury to meet the day before the burying-day and inquire into all causes of death. In most cases the inquiry would be formal, but it would give an opportunity for any person aggrieved to come into court and complain. The jury would not always be the same men, and many of them would take care to look round the building, and being ratepayers, would see if they were having their money's worth for their money. They would have an opportunity of looking at the bread and tasting the soup and seeing the actual condition of the paupers themselves. This would be a very much more effectual way of inquiring than the farcical tribunals conducted by a Poor Law Inspector. At the inquiry conducted by Mr. Farnall into the death of Gibson at St. Giles's Workhouse, he directed a loaf of bread to be brought and shown a medical witness, and then asked him if he did not think it very good. The loaf might or might not have been brought from the workhouse stock, but this is a specimen of the way in which Government inquiries are conducted.

But even were it not thought desirable to hold an inquest on every person that dies throughout the United Kingdom, there is no doubt that an advantage would arise from the Coroner having sent up to him a fully filled-up information in the case of every death in a workhouse. He could then examine the details and decide for himself as to whether an inquest should be held or not.

Whilst on the subject of Prison and Workhouse management we may refer to the very unsatisfactory state of the Dietaries in Irish prisons. This subject was brought before Parliamement during its last summer Session by Mr. John A. Blake, Member for Waterford. The subject was also brought before the Health Department of the Social Science Congress at Belfast* by Dr. Lankester. The complaint of Mr. Blake was that the diet was scanty

* See abstract of a paper "On Prison and Workhouse Dietaries," by Dr. Lankester, in 'British Medical Journal,' Nov. 2, 1867.

and innutritious, and Dr. Lankester pointed out its deficiencies, as also that the food was administered to the prisoners only twice a day. The great argument employed in favour of the exceedingly low dietaries of the Irish prisons is, that if it were better the people would commit crimes in order to be taken into prison to get a better diet than they could get out. Now the Irish prison dietaries cost many of them as little as twopence-halfpenny a day for each prisoner and seldom reach the cost of fourpence. If this diet, as is stated, is not lower than the diet the people of Ireland get out of jail, it reveals a feature in Ireland that is much worse than a deficient prison dietary, and that is a really starving people. If such dietaries as those of the Irish prisons are fixed at the present low nutritive value lest people should be tempted to commit crime to partake of them, the Irish destitution must be worse than any thing England has ever yet contemplated. The apologists for the low diet at the Belfast meeting stated that the majority of prisoners were only confined for short periods, and that low diet for a short time did no harm. We would call the attention of philanthropists to this dangerous doctrine. If men have been living upon so low a diet that a little better diet in a prison may tempt them to commit crime in order to get it, what must be the effect of a low diet on such systems but that of lowering them still further, and rendering them unfit for the performance of the work by which they get their daily bread? An inducement to the commission of petty theft is that feebleness of body which makes work impossible, and the object of punishment for such crimes should be the rendering a man more able to work than he had been. Besides, these miserably low diets depress the powers of the nervous system, and make men much more liable to become the prey of despair, and to a tendency to commit crime. To withhold from men the means of vicious indulgence in eating and drinking in prison is undoubtedly the duty of a Government, but to give men a diet that is insufficient to support the health of the body is to inflict a punishment that defeats its own objects, and frequently leads to the remote consequences of disease and death, which the spirit of our criminal law condemns as unjust.

Quite independent of the low dietaries of the Irish prisons is the question of the times at which the food is served, the way it is cooked, and its quality. From the last report of the Inspector of Prisons, there is reason to believe that at least occasionally the food is not so good as it ought to be, and that it is not cooked so well, nor served so hot as it ought to be; whilst universally the practice is to give but two meals a day. Now it ought to be known everywhere that food served hot goes further than food served cold; and that the same quantity of food given three or four times a day goes further than when given twice a day. It is often death to old

persons, in prisons and workhouses, to go from four or five p.m. one day, to eight or nine a.m. the next day, without food.

We have received accounts of sanitary proceedings from various parts of the country. A copy of the 'Scotsman' has been forwarded to us, containing a letter, printed in prominent type, concerning the sanitary improvements about to be made in that city. It is the old story—large sums of money have been voted for the amelioration of the condition of the lowest classes, by improving the closes and alleys; and that money is now said to be expended in work, no doubt in itself useful, but of a far less pressing nature. In Worcester a great battle is being fought on the question of appointing a medical officer of health. Although Worcester has been recently drained, and has got a good water supply from the Severn, its annual mortality is large. During the last three years it has been as high as twenty-seven in the thousand, and this has alarmed some of the more thoughtful and prudent of the inhabitants. In the end of the year 1866 the Sanitary Committee of Worcester appointed a sub-committee to report on the condition of the town. They report that many parts of the town, in addition to obvious abominations—such as general want of cleanliness—present nuisances, "such as overflowing privies and cesspools; imperfect drains, or an entire absence of them; houses dilapidated and rooms injurious to health for want of proper whitewashing and ventilation; which may be taken as a sample of what is always, to a greater or less extent, prevalent in the midst of the population." The same report says that, "Many dwellings are greatly overcrowded;" that "typhoid fever is endemic in Worcester, and it is clearly traceable to foul drains and privies, and the use of polluted well-water." Amongst the evils in this fine cathedral city—although amply supplied with water from the Severn—is the use of wells for the supply of water. There are certain people in Worcester, as in London and other places, who believe that the water from wells, surrounded by drains and cesspools, and supplied by water from the leakage of these places, is better than any other water: the consequence is, they pay for their temerity with their lives. All this comes out in the report of the Sanitary Sub-Committee referred to, and they very properly recommend the appointment of a medical officer of health, whose duty it shall be to watch the health of the town, and immediately carry into effect the various sanitary laws which have for their object the saving of the lives and healths of the community. But somehow or other, the Town Council do not see their way to put down disease and death by spending money. They seem to think that doctors, and under-takers, and grave-diggers have a right to live, as well as other people. To diminish the death-rate of Worcester from twenty-seven to seventeen in the thousand (a thing easy to be done), would be to

save the lives of 400 people in the year, and 8,000 illnesses into the bargain. To be sure, that would be an enormous gain to Worcester, equal, at least, to a sum of 10,000*l.* per annum, when properly calculated; but then it would not appear in the rate-books. Town councils and vestries are everywhere alike, utterly *regardless* of the health and lives of their fellow-creatures, but particularly anxious to keep down the rates.

We are glad to report that the New Drainage at Hastings and St. Leonards has just been completed. The works have been executed by Mr. Bazalgette. The sewage is now taken out to such a distance into the sea as to render it impossible that it should ever return to the shore, and the sea will be now uncontaminated with the sewage of the town. It is to be hoped that the local authorities will take care that every house in the town is supplied with drains and a water-closet, so that all those diseases which are dependent on the retention of sewage-matters near houses may be for ever abolished.

A report comes to us from Sandown, in the Isle of Wight, of a very extraordinary character. Sandown is one of those watering-places on our coast which are very likely to become unhealthy through the grasping economy of the tradespeople, who prey upon their visitors who come for health. Fortunately, however, for Sandown, a portion of its land became possessed by a leading barrister on the Northern Circuit, distinguished for his attainments in natural science and his practical knowledge of sanitary measures. Principally through his agency, Sandown has been thoroughly drained and supplied with an abundance of pure water. The consequence has been, that ordinary epidemics are unknown in Sandown, and the bills of the mortality in the last five years show a death-rate *of only eleven in the thousand.* We would call general attention to this remarkable case, as it clearly shows what may be done by ordinary sanitary activity. This is, probably, the lowest death-rate on record. Every local body in the kingdom would do well to study Sandown. It is not a rich place. It is not a place of palaces alone. It has poor and rich, and closely resembles other towns in the character of its population, but it has this peculiarity, its drainage and water supply are perfect.

As an instance of how an otherwise healthy village in the country may be made to rival the largest towns in its filth, disease, and death, we may mention the village of Child's Hill, in the parish of Hendon, in Middlesex. The village has no system of drainage; to many of the houses there are privies with open cesspools, which overflow into the neighbouring ditches, which ultimately empty themselves into the Brent. The population is about 1,000. During the summer of 1860, dropping cases of typhoid fever occurred in this village, and in 1867 this disease became an epidemic,

so that during the months of July and August last, the mortality of the district was equal to seventy in the 1,000 per annum. We are glad to hear that the village has now constituted itself a sewage district under the Sanitary Act of 1866, and that a vestry for the district has been appointed, and that a perfect system of drainage will be completed before the next summer. Would that parishes would be wise in time, and act before so much life and health has been destroyed. There must be many thousand villages in England suffering in the same way as Child's Hill. It cannot be too widely known that typhoid fever is the child of deficient drainage, and that it cannot arise or be propagated where this agent does not exist.

Quarterly List of Publications received for Review.

1. Miscellanies: being a Collection of Memoirs and Essays on Scientific and Literary Subjects, published at various times. By Charles Daubeny, M.D., F.R.S. 2 vols. 8vo.
James Parker & Co.

2. Siluria. A History of the Oldest Rocks in the British Isles and other Countries; with Sketches of the Origin and Distribution of Native Gold, the General Succession of Geological Formations, and Changes of the Earth's Surface. By Sir Roderick I. Murchison, Bart., K.C.B., D.C.L., LL.D., F.R.S. Fourth Edition. 600 pp. 8vo. 42 *Plates and* 206 *Woodcuts.*
John Murray.

3. The States of the River Plate. By Wilfred Latham. Second Edition. *With a Map.* *Longmans & Co.*

4. Practice with Science. A Series of Agricultural Papers. Vol. I. 400 pp. 8vo. *Longmans & Co.*

5. Handbook of the History of Philosophy. By Dr. Albert Schwegler. Translated and annotated by James Hutchinson Stirling, LL.D. 420 pp. Post 8vo. *Edinburgh: Edmonstone & Douglas.*

6. The Darwinian Theory of the Transmutation of Species Examined by a Graduate of the University of Cambridge. 400 pp. 8vo. *Nisbet & Co.*

7. Germinal Matter and the Contact Theory: an Essay on the Morbid Poisons, their Nature, Sources, Effects, Migrations, and the Means of limiting their Noxious Agency. By James Morris, M.D. (London), Fellow of University College. Second Edition. 120 pp. Crown 8vo. *John Churchill & Sons.*

8. Results of Astronomical Observations made at the Melbourne Observatory, under the Direction of Robert L. J. Ellery, Government Astronomer to the Colony of Victoria, Australia.
Melbourne: Blundell & Ford.

9. Report of the Secretary of War, with Accompanying Papers. Washington, U.S.A.

10. Schriften der königlichen physikalisch-œkonomischen Gesellschaft zu Königsberg (for 7 years). 4to. *With numerous Illustrations on Stone, Copper, and Wood.*
Königsberg: Graefe & Unzer.

11. The Botany of Worcestershire, by Edwin Lees, F.L.S., F.G.S. 290 pp. 8vo. *With Map.*
The Worcestershire Naturalist's Field Club.

12. Outlines of Physiology, Human and Comparative. By John Marshall, F.R.C.S. 2 vols. Crown 8vo. 1,300 pp. *With* 122 *Woodcuts.* *Longmans & Co.*

PAMPHLETS, PERIODICALS, &c.

On the Recent Zoology and Palæontology of Victoria. By Frederick M'Coy, Professor of Natural Science in the University of Melbourne. 24 pp. 8vo.

Observations and Experiments on Living Organisms in Heated Water. By Jeffries Wyman, M.D., Harvard College. 20 pp. 8vo.

Practical Hints to the Medical Student. By William Allen Miller, M.D., LL.D., F.R.S. 32 pp. 8vo. *Longmans & Co.*

New Facts and Old Records: a Plea for Genesis. By S. R. Pattison, F.G.S. 30 pp. 8vo. *Jackson, Walford, & Hodder.*

An Investigation of the Distance of the Sun, and of the Elements which depend upon it, from the Observation of Mars, made during the Opposition of 1862; and from other Sources. By Simon Newcomb, U.S. Navy. 30 pp. 4to.

On State Medicine in Great Britain and Ireland. By Henry W. Rumsey, M.D., F.R.C.S. 58 p.p. 8vo. *From the Author.*

On the Middle and Upper Lias of the South-West of England. By Charles Moore, F.G.S. 7 *Plates.* 130 pp. 8vo.
From the Author.

Sun-Views of the Earth, or The Seasons Illustrated. By Richard A. Proctor, B.A., F.R.A.S. 18 *Coloured Plates.* 4to.
Longmans & Co.

Note on the Surface Geology of London; with Lists of Wells and Borings, showing the Thickness of the Superficial Deposits. By Wm. Whittaker, B.A., F.G.S. 22 pp. 8vo.

On the Physiological Action of the Calabar Bean. By Thos. R. Frazer, M.D.

Rain: How, When, Where, Why, it is Measured? *G. J. Symons.*

The Liverpool Medical and Surgical Reports. Edited by F. T. Roberts, M.B., D.Sc., and Reginald Harrison, F.R.C.S.
London: Churchill & Sons. Liverpool: Holden.

Lichenes Spitzbergenses. Determinavit Th. M. Fries..
Stockholm: Norstedt & Söhne.

Spitzbergen's Insect Fauna. By Carl H. Boheman.
Received from Dr. A. Malmgren, Helsinfors.

The New Science of Astronomy, as set forth in Chap. xii. of "The Analogies of Being." To which is appended the Sectional Analysis of the Sixteen Chapters composing that Work. By Joseph Wood. 70 pp. 8vo. *Farrah, 282, Strand.*

The Auriferous and other Metalliferous Districts of Northern Queensland. W. B. Clarke, M.A., F.G.S. (V.P. Royal Society of New South Wales).

Prison and Workhouse Dietaries. By Edwin Lankester, M.D., F.R.S.

On the Distribution of Temperature in the Lower Region of the Earth's Atmosphere. By Henry Hennessy, F.R.S. *Dublin: Gill.*

The Distribution of Plants in Canada in some of its Relations to Physical and past Geological Conditions. By A. T. Drummond, B.A., LL.B. 16 pp. 8vo. *From the Author.*

On the Supply of Dwellings in Large Towns for Artizans and Labourers. Jos. Boult, F.R.I.B.A.

Supply of Meat from South America. By A. Prange.

Second Report of the Queckett Microscopical Club.

Smithsonian Reports and Transactions:

Geological Researches in China, Mongolia, and Japan. By Raphael Pumpelly.

Freshwater Glacial Drift of the North-Western States. By Charles Whittlesey.
From the Smithsonian Institution, Washington, U.S.A.

The American Naturalist.

The American Journal of Mining.

The Canadian Naturalist and Geologist, and Proceedings of the Montreal Natural History Society.

Le Mouvement Médical.

The Geological Magazine.

The Westminster Review.

Report of the Liverpool Free Public Library.

Proceedings of the Royal Institution of Great Britain.
" " Royal Society.
" " Royal Astronomical Society.
" " Chemical Society of London.
" " Royal Geographical Society.
" " Zoological Society of London.

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